In Reply Refer To:
13410-2011-F-0148

Michael J. Lidgard
NPDES Permits Unit
ATTN: Hanh Shaw
U.S. EPA – Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

Dear Mr. Lidgard:

Subject: Biological Opinion – City of Puyallup Wastewater Treatment Plant NPDES Permit Reissuance (Permit No. WA-003716-8)

The U.S. Environmental Protection Agency – Region 10 (EPA) proposes to reissue a National Pollutant Discharge Elimination System permit to the City of Puyallup, Washington, for continued operation of their municipal wastewater treatment plant. The EPA's issuance of a permit under the Clean Water Act (33 U.S.C. 1251 *et seq*., as amended) establishes a nexus requiring consultation under section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.)(Act).

This document transmits the U.S. Fish and Wildlife Service's Biological Opinion (Opinion) based on our review of the proposed action, and its potential effects to the bull trout (*Salvelinus confluentus*) and designated bull trout critical habitat. This formal consultation has been conducted in accordance with the Act.

The EPA provided information in support of a "may affect, likely to adversely affect" determination for the bull trout. The City of Puyallup's treatment plant discharges to a stretch of the Puyallup River which the Service has excluded from the bull trout critical habitat designation (50 FR 63898 [October 18, 2010]. We expect that the action will have no measurable adverse effects to designated bull trout critical habitat located downstream of the 1873 survey area of the Puyallup Reservation.

The enclosed Opinion addresses the proposed actions' adverse effects to the bull trout, and includes mandatory terms and conditions intended to minimize certain adverse effects. The EPA has determined that the action will have "no effect" on additional listed species and critical habitat known to occur in Pierce County, Washington. There is no requirement for Service concurrence on "no effect" determinations. Therefore, your determinations that the action will have no effect on these species and critical habitat rest with the Federal action agency.

If you have any questions regarding the Opinion or your responsibilities under the Act, please contact Ryan McReynolds at (360) 753-6047, or Martha Jensen at (360) 753-9000, of this office.

Sincerely,

Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc:
Puyallup Tribe of Indians, Tacoma, WA (C. Naylor and B. Sullivan)
NMFS, Lacey and Seattle, WA (J. Fisher, S. Anderson, and T. Mongillo)

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Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference: 13410-2011-F-0148

City of Puyallup Wastewater Treatment Plant
NPDES Permit Reissuance

Pierce County, Washington

Agency:

U.S. Environmental Protection Agency
Region 10, Seattle, Washington

Consultation Conducted By:

U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

Ken S. Berg, Manager Washington Fish and Wildlife Office	Date

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LIST OF ACRONYMS AND ABBREVIATIONS [Needs Admin Help]

Act	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
BA	Biological Assessment
BMP	Best Management Practices
Cu	Copper
FHWA	Federal Highway Administration
FMO	Foraging, Migration and Overwintering
NTU	Nephelometric Turbidity Units
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
PCE	Primary Constituent Elements
PGIS	pollution-generating impervious surface
RPM	Reasonable and Prudent Measures
SEL	sound exposure level
Service	U.S. Fish and Wildlife Service
SEV	Severity of Effect
SL	sound level
SPCC	Spill Prevention, Control and Countermeasures
SPL	sound pressure level
SQG	sediment quality guidelines
SR	State Route
TDA	threshold discharge areas
TEL	Threshold Effect Levels
TL	transmission loss
TMDL	Total Maximum Daily Load
TSS	Total suspended solids
TTS	Temporary Threshold Shift
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
Zn	Zinc

CONSULTATION HISTORY

The U.S. Environmental Protection Agency – Region 10 (EPA) proposes to reissue a National Pollutant Discharge Elimination System (NPDES) permit to the City of Puyallup, Washington, (City) for continued operation of their municipal wastewater treatment plant (WWTP or plant). The proposed NPDES permit would have a term of five years from the effective date (2012-2017), and would establish effluent limitations, prohibitions, best management practices (BMPs), and other conditions governing the discharge of pollutants to waters of the United States.

The City's WWTP discharges to the lower Puyallup River at approximate river mile (RM) 6.9, located within the 1873 survey area of the Puyallup Reservation. The Puyallup Tribe of Indians (Puyallup Tribe) is the beneficial owner of the bed and banks of the Puyallup River within the 1873 survey area, which the United States holds in trust for the Puyallup Tribe. The Puyallup Tribe designates beneficial uses and establishes surface water quality standards for waters within the Reservation, and will issue a Clean Water Act (CWA) Section 401 Certification as part of the NPDES permit process. The EPA's issuance of a NPDES permit under the CWA (33 U.S.C. 1251 *et seq*., as amended) establishes a nexus requiring consultation under section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.)(Act).

The U.S. Fish and Wildlife Service (Service) based this Biological Opinion (Opinion) on the following sources of information:

- Biological Evaluation (BE) for Reissuance of the City of Puyallup NPDES Permit (March 30, 2012);
- NPDES Permit No. WA-003716-8, preliminary draft copy (received April 6, 2012);
- Fact Sheet - Permit No. WA-003716-8, preliminary draft copy (received April 6, 2012);
- A field review of the project site; and,
- Various scientific literature and personal communications cited herein.

A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Lacey, Washington.

The following timeline summarizes the history of this consultation:

February 18, 2011 – The EPA submits a BE and requests informal consultation to address potential effects to the bull trout (*Salvelinus confluentus*).

May 13, 2011 – The Service transmits a letter of non-concurrence, requests additional information in support of consultation, and recommends that the EPA reexamine the potential for adverse effects to the bull trout.

April 3, 2012 – The EPA submits a revised BE providing information in support of a "may affect, likely to adversely affect" determination for the bull trout. The Service initiates formal consultation on the proposed action.

April 6, 2012 – The EPA provides preliminary draft copies of the pending NPDES permit and fact sheet.

April 26, 2012 – The Service meets with the EPA, Puyallup Tribe, and National Marine Fisheries Service (NMFS) to discuss the schedule for consultation, public notice for the draft permit, and permit issuance.

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Month Day, 2012 – The Service shares a copy of the draft Opinion with the EPA for their review and comment...

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The EPA proposes to reissue a NPDES permit to the City of Puyallup, Washington, (City) for continued operation of their municipal WWTP. The proposed NPDES permit would have a term of five years from the effective date (2012-2017), and would establish effluent limitations, prohibitions, BMPs, and other conditions governing the discharge of pollutants to waters of the United States. Issuance of a NPDES permit under the CWA establishes a nexus requiring consultation under section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.)(Act).

WWTP Configuration

The City's WWTP has a maximum monthly design flow of 13.98 million gallons per day (mgd), but currently treats an average flow of approximately 4 mgd, and a maximum monthly average flow of approximately 8.8 mgd (EPA 2012a, p. 2). The plant provides secondary treatment for domestic and pre-treated industrial wastewaters, utilizing an activated sludge system with ultraviolet light disinfection. The City's collection and conveyance system was originally constructed as a combined stormwater and sanitary system, but according to the EPA these flows are now completely separated (EPA 2012c, p. 6).

The City's WWTP discharges to the lower Puyallup River at approximate RM 6.9, located within the 1873 survey area of the Puyallup Reservation (Figure 1). Treated and disinfected wastewater discharges by way of a 42-inch trunk line and 26-port diffuser, located approximately 40 ft waterward of the Puyallup River's left-bank (Figure 2).

Permit Framework and Recent History

The Puyallup Tribe is the beneficial owner of the bed and banks of the Puyallup River within the 1873 survey area, which the United States holds in trust for the Puyallup Tribe. The Puyallup Tribe designates beneficial uses and establishes surface water quality standards for waters within the Reservation. The Puyallup Tribe will issue a CWA Section 401 Certification as part of the NPDES permit process.

The EPA, Puyallup Tribe, and Washington State Department of Ecology (Ecology) share responsibility for implementation of the NPDES permit program on the Reservation (Memorandum of Agreement, 1997). The Memorandum of Agreement recognizes the federal government's authority to issue NPDES permits for discharges to waters of the Reservation (EPA 2012c, p. 6). Previous permits were issued to the City, or were modified, during August 2003 and April 2008. The City is currently operating their municipal WWTP under an administratively extended authorization to discharge (EPA 2012c, p. 6).

Figure 1. Vicinity map - City of Puyallup WWTP and outfall.

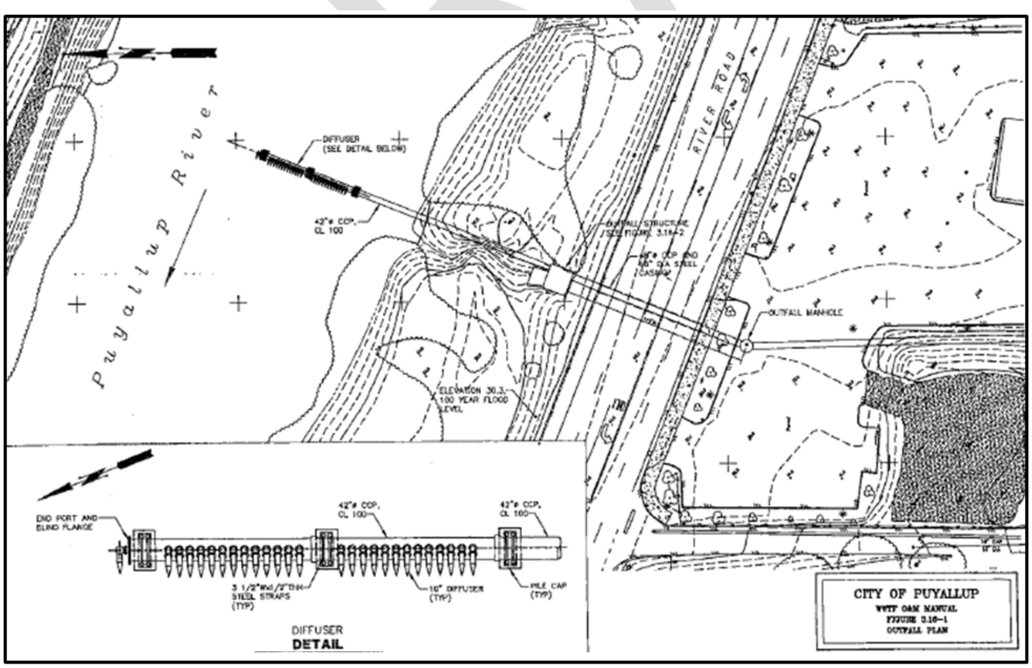


Figure 2. WWTP outfall configuration.

The Puyallup Tribe's Water Quality Standards (WQS) designate beneficial uses for waters of the Reservation. The current standards designate the Puyallup River in the vicinity of the outfall as a Class A waterbody (EPA 2012c, p. 5). Characteristic uses include domestic, industrial, and agricultural water supply, fish and shellfish, wildlife habitat, ceremonial and religious water uses, commerce, navigation, and recreation. The Puyallup Tribe's WQS establish an antidegradation policy, aquatic life criteria for temperature, dissolved oxygen, and pH, and toxic pollutant water quality criteria for the protection of aquatic life and human health (EPA 1994). Table 1 summarizes some of the most relevant Puyallup Tribe WQS, which apply to the Puyallup River between RMs 1.0 and 7.3.

Table 1. Puyallup Tribe WQS.

Aquatic Life Criteria – Salmonid Migration		
Temperature	18 °C (7-DADMax) 7-Day Average of the Daily Maximum Temperature	
Dissolved Oxygen	8.0 mg/L	
pH	6.5 to 8.5 Human-Caused Variation < 0.5 Units	
Toxics Criteria – Aquatic Life and Human Health		
Parameter	**Acute Criteria** (one-hour average)	**Chronic Criteria** (four-day average)
Ammonia (Summer)	140 µg/L Unionized[a]	31 µg/L Unionized[a]
Ammonia (Winter)	85 µg/L Unionized[a]	19 µg/L Unionized[a]
Copper	6.97 µg/L Dissolved[b]	3.17 µg/L Dissolved[b]
Mercury	2.40 µg/L Total	0.012 µg/L Total
Zinc	51.5 µg/L Dissolved[b]	29.7 µg/L Dissolved[b]

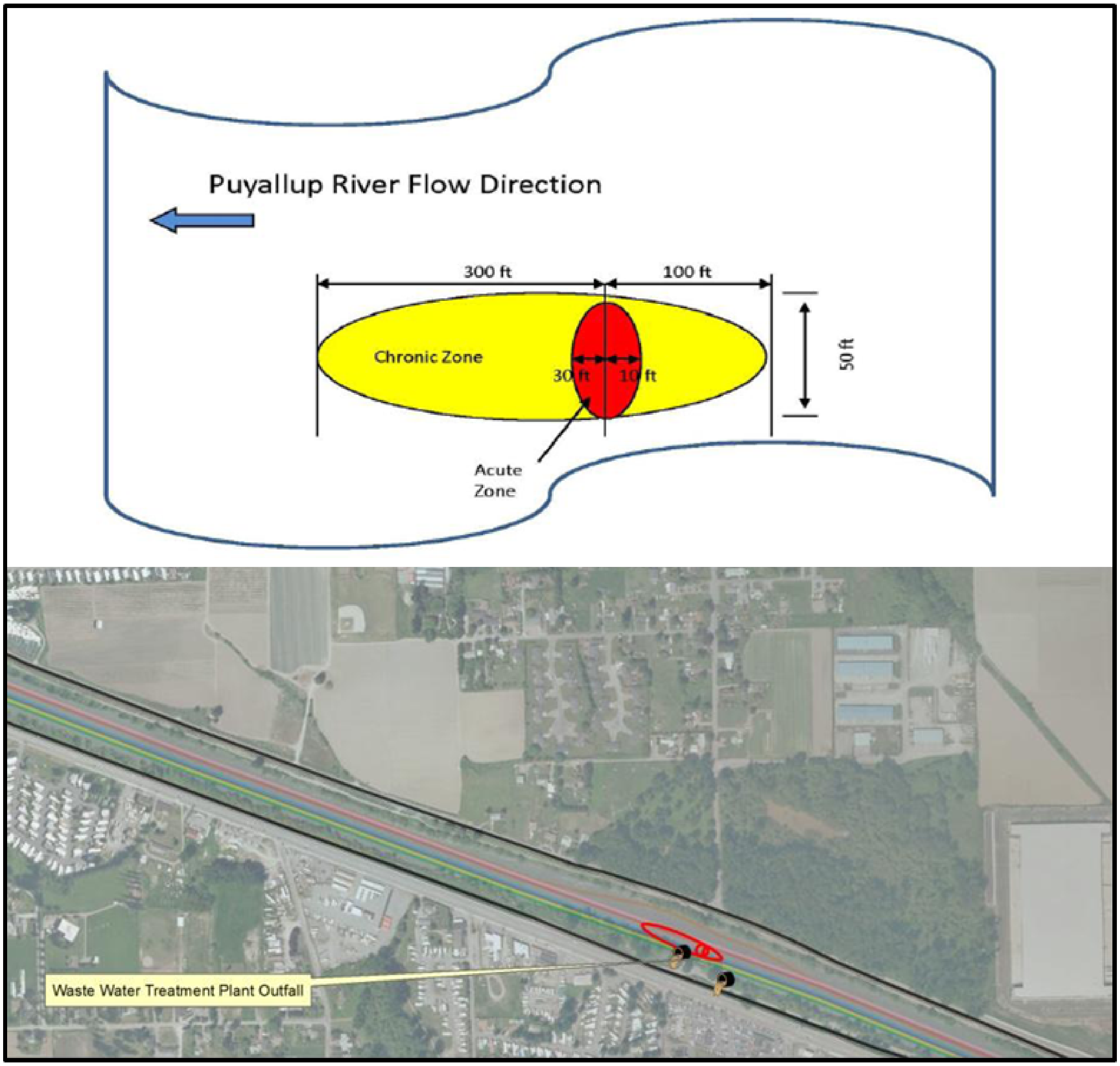
Source: (EPA 1994, pp. 1, 9, 10, 15-19; EPA 2012c, pp. 33-39).

a Numerical criteria for ammonia are expressed as a function of pH and temperature; the values reported here were determined by the EPA, with reference to 90th percentile receiving water pH and temperature conditions.

b Numerical criteria for dissolved metals (Cu and Zn) are expressed as a function of water hardness; the values reported here were determined by the EPA, with reference to receiving water hardness.

Under the Puyallup Tribe's WQS "…dischargers are not authorized to use the entire upstream flow for dilution of their effluent." Instead, the WQS specify the following for determining compliance with chronic criteria: "the size [of the allowable mixing zone] may be up to 300 feet plus the depth of water over the discharge ports, 100 feet upstream, and 25 percent of the width of the river at the 7Q10 [7-day, 10-year low] flow;" and, "…the mixing zone may not be more than 25 percent of the volume of the 7Q10 flow" (EPA 2012c, p. 27). The WQS require that the acute mixing zone be the same width and 10 percent of the length of the chronic mixing zone. Therefore, the allowable acute mixing zone is limited to 10 percent of the volume of the chronic mixing zone, or 2.5 percent of the 7Q10 flow. Figure 3 depicts maximum dimensions for the City of Puyallup WWTP mixing zones as allowed under the Puyallup Tribe's WQS. The horizontal length of the diffuser is approximately 50 ft, and the Puyallup River is approximately 207 ft wide at the point of discharge during low flows (EPA 2012c, p. 27). Figure 3 also illustrates the size of the allowable WWTP mixing zones relative to the larger receiving water (lower Puyallup River, approximate RM 6.9).

Figure 3. Allowable mixing zone dimensions, chronic and acute.



Permit Conditions

Under previous permits issued to the City for operation of their municipal WWTP, and for the current proposed permit, the EPA has applied technology-based limits, has determined appropriate acute and chronic water quality criteria (based on the applicable WQS and receiving water conditions), has evaluated mixing-zone dilution factors and critical mixing conditions, and has determined and incorporated wasteload allocation(s) based on applicable Total Maximum Daily Loads (TMDLs). These data and considerations are the basis for the effluent limitations, discharge concentrations and loads, which have been included in the draft permit by the EPA (Table 2).

Effluent limitations established by the EPA for the proposed permit include a technology-based limit for total suspended solids (TSS) and water quality-based effluent limitations for 5-day biochemical oxygen demand (BOD_5), fecal coliform bacteria, total ammonia (or Ammonia-N), total copper (or Total-Cu), and pH (measure of acid-base equilibrium). The effluent limitations include average monthly and weekly limits, maximum daily limits, and seasonal limits ("winter" and "summer"; Ammonia-N only) (Table 2).

Table 2. Effluent limitations, EPA Permit No.WA-003716-8.

Pollutant / Parameter	**Average Monthly**		**Average Weekly**		**Maximum Daily**	
	Concentration	Load	Concentration	Load	Concentration	Load
BOD_5[a]	30 mg/L	2179 lbs./day	45 mg/L	3268 lbs./day	---	---
TSS	30 mg/L	2333 lbs./day	45 mg/L	3499 lbs./day	---	---
Fecal Coliform	100 colonies/100 mL		---	---	---	---
Ammonia-N "Winter"[a]	5.4 mg/L	793 lbs./day	---	---	16.1 mg/L	2622 lbs./day
Ammonia-N "Summer"[a]	4.2 mg/L	490 lbs./day	---	---	12.0 mg/L	792 lbs./day
Total-Cu	7.1 µg/L	0.83 lbs./day	---	---	13.7 µg/L	1.60 lbs./day
pH	---	---	---	---	6.5 – 9.0 Standard Units	

Source: (EPA 2012b, pp. 5-7).

[a] BOD_5 and Ammonia-N loads reflect wasteload allocations, and a requested "trade" between allowable BOD_5 and Ammonia-N loads (EPA 2012c, pp. 31-34).

The proposed effluent limitations include modestly more stringent average monthly and maximum daily limits for winter total ammonia (discharge concentrations and loads), than those included in the previous permit (EPA 2012c, pp. 8, 9; EPA 2012a, pp. 3-5). The proposed effluent limitations also include modestly more stringent average monthly limits for total copper (discharge concentrations and loads), than those previously included. The proposed permit does not "carry through" (i.e., no longer establishes) effluent limitations for three metals with specific limits under the previous permit (lead, mercury, and zinc)(EPA 2012c, pp. 8, 9). The EPA has determined that copper demonstrates a reasonable potential, but lead, mercury, and zinc do not demonstrate a reasonable potential, to contribute to exceedances of applicable WQS (or "excursions above criteria") at the edge of the allowable mixing zones (EPA 2012c, pp. 35, 36; EPA 2012a, p. 8). The proposed permit establishes effluent limitations designed and applied for the specific purpose of ensuring that discharges from the City of Puyallup WWTP fully comply with applicable WQS, including the allowable mixing zone dimensions.

Additional permit conditions established by the EPA include or address pre-treatment requirements for industrial wastewater generators/contributors, testing and monitoring requirements, an operation and maintenance (O&M) plan including current BMPs, reporting requirements, an emergency response and public notification plan, and compliance responsibilities (including penalties for violations, bypass and upset conditions)(EPA 2012b, pp. 5-33). The testing and monitoring requirements are extensive, and include effluent and receiving water monitoring, new nutrient monitoring requirements, and annual Whole Effluent Toxicity testing.

The EPA (Region 10) issues separate permits for wastewater discharges and disposal of generated biosolids. The EPA regulates disposal of biosolids subject to national standards (40 CRF Part 503), and intends to issue a separate, "sludge-only" general permit to multiple facilities (including the City of Puyallup WWTP) at a later date (EPA 2012c, p. 10).

ACTION AREA

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The EPA has modeled effluent plume dynamics for the City of Puyallup WWTP applying conservative assumptions (EPA 2012a, pp. 10-13). Using ambient or background water quality data obtained from a nearby, upstream long term monitoring station (WDOE 2012), and 99th percentile WWTP effluent concentrations, the EPA has demonstrated that the effluent plume becomes completely mixed such that there is no measurable difference from background for the most conservative indicator at a distance of approximately 1.2 miles downstream (EPA 2012a, pp. 10-13).

The proposed action will not create or provide additional WWTP capacity. The proposed action will have no foreseeable indirect effects to the pattern or rate of land use conversion or development. Biosolids management and disposal are regulated under a separate permit (EPA 2012c, p. 10), and therefore the sites and/or facilities where biosolids are processed and disposed are not included as part of the action area.

The action area includes the City of Puyallup WWTP, the existing outfall pipe and diffuser located waterward of the Puyallup River's left-bank, and the bed and banks of the lower Puyallup River, extending from the point of discharge (RM 6.9) a distance of approximately 1.2 miles downstream, and 100 ft upstream (RMs 5.7 to 6.9).

ANALYTICAL FRAMEWORK FOR THE JEOPARDY DETERMINATION

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this Opinion relies on four components: (1) the *Status of the Species*, which evaluates the species' rangewide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

The jeopardy analysis in this Opinion places an emphasis on consideration of the rangewide survival and recovery needs of the species and the role of the action area in the survival and recovery of the species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

STATUS OF THE SPECIES (BULL TROUT)

The rangewide status of the bull trout is provided in Appendix A.

PUYALLUP RIVER CORE AREA SUMMARY (BULL TROUT)

[From Refworks Template with No Changes – TRMcR –] The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within Mount Rainier National Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed.

Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Bull trout occur throughout most of the system although spawning occurs primarily in the headwater reaches. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within Puget Sound. Habitat conditions within the lower mainstem Puyallup and White Rivers have been highly degraded, retaining minimal instream habitat complexity. In addition, habitat conditions within Commencement Bay and adjoining nearshore areas have been severely degraded as well, with very little intact intertidal habitat remaining.

The Puyallup core area has the southernmost, anadromous bull trout population in the Puget Sound Management Unit (USFWS 2004, Vol. 2 p. 19). Consequently, maintaining the bull trout population in this core area is critical to maintaining the overall distribution of migratory bull trout in the management unit.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, Vol. II p. 215).

Number and Distribution of Local Populations

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Clearwater River is identified as a potential local population, as bull trout are known to use this river and it appears to provide suitable spawning habitat, but the occurrence of reproduction there is unknown (USFWS 2004, Vol 2 pp. 119-121).

Information about the distribution and abundance of bull trout in this core area is limited because observations have generally been incidental to other fish species survey work. Spawning occurs in the upper reaches of this basin where higher elevations produce the cold water temperatures required by bull trout egg and juvenile survival. Based on current survey data, bull trout spawning in this core area occurs earlier in the year (i.e., September) than typically observed in other Puget Sound core areas (Marks et al. 2002). The known spawning areas in local populations are few in number and not widespread. The majority of spawning sites are located in streams within Mount Rainier National Park, with two exceptions, Silver Creek and Silver Springs (Ladley, in litt. 2006; Marks et al. 2002).

Rearing likely occurs throughout the Upper Puyallup, Mowich, Carbon, Upper White, West Fork White, and Greenwater Rivers. However, sampling indicates most rearing is confined to the upper reaches of the basin. The mainstem reaches of the White, Carbon, and Puyallup Rivers probably provide the primary freshwater foraging, migration, and overwintering habitat for migratory bull trout within this core area.

With fewer than 10 local populations, the Puyallup core area is considered to be at intermediate risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

Rigorous abundance estimates are generally not available for local populations in the Puyallup core area. Currently, fewer than 100 adults probably occur in each of the local populations in the White River system, based on adult counts at Mud Mountain Dam's Buckley Diversion fish trap. Although these counts may not adequately account for fluvial migrants that do not migrate downstream of the facility, these counts do indicate few anadromous bull trout and few mainstem fluvial bull trout return to local populations in the White River system. Therefore, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess adult abundance in each local population.

Productivity

Due to the current lack of long-term, comprehensive trend data, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess productivity.

Connectivity

Migratory bull trout are likely present in most local populations in the Puyallup core area. However, the number of adult bull trout expressing migratory behavior within each local population appears to be very low compared to other core areas. Although connectivity between the Upper Puyallup and Mowich Rivers local population and other Puyallup core area local populations was reestablished with the creation of an upstream fish ladder at Electron Dam in 2000, this occurred after approximately 100 years of isolation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap. The overall low abundance of migratory life history forms limits the possibility for genetic exchange and local population refounding, as well as limits more diverse foraging opportunities to increase size of spawners and therefore, overall fecundity within the population. Consequently, the bull trout population in the Puyallup core area is at intermediate risk of extirpation from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, the Service has issued Biological Opinions that exempted incidental take in the Puyallup core area. These incidental take exemptions were in the form of harm and harassment, primarily from hydrologic impacts associated with increased impervious surface, temporary sediment increases during in-water work, habitat loss or alteration, and handling of fish. None of these projects were determined to result in jeopardy to bull trout. The combined effects of actions evaluated under these Biological Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Of particular note, in 2003 the Service issued a Biological Opinion (FWS Ref. No. 1-3-01-F-0476) on the State Route 167 North Sumner Interchange Project. This project was located in Pierce County in the White River portion of the Puyallup watershed and was proposed by Washington State Department of Transportation. The project's direct and indirect impacts and cumulative impacts within the action area included urbanization of approximately 600 acres of land. We anticipated that conversion of this land to impervious surface would result in the permanent loss and/or degradation of aquatic habitat for bull trout and their prey species through reduced base flows, increased peak flows, increased temperatures, loss of thermal refugia, degradation of water quality, and the degradation of the aquatic invertebrate community and those species dependent upon it (bull trout prey species). These impacts will result in thermal stress and disrupt normal behavioral patterns. Incidental take of fluvial, adfluvial, and anadromous bull trout in the form of harassment due to thermal stress and the disruption of migrating and foraging behaviors was exempted for this project. These adverse effects were expected to continue in perpetuity.

Section 10(a)(1)(B) permits have also been issued for Habitat Conservation Plans (HCPs) that address bull trout in this core area. Although these HCPs may result in both short and/or long-term negative effects to bull trout and their habitat, the anticipated long-term beneficial effects are expected to maintain or improve the overall baseline status of the species. Additionally, capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have directly affected some individual bull trout in this core area.

The number of non-Federal actions occurring within the Puyallup core area since the bull trout were listed is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance affect riparian and instream habitat which typically results in negative effects to bull trout and their habitat.

Threats

Threats to bull trout in the Puyallup core area include:

- Extensive past and ongoing timber harvest and harvest-related activities, such as road maintenance and construction, continue to affect bull trout spawning and rearing areas in the upper watershed.

- Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications continue to affect foraging, migration, and overwintering habitats for bull trout in the lower watershed.

- Dams and diversions have significantly affected migratory bull trout in the core area. Until upstream passage was recently restored, the Electron Diversion Dam isolated bull trout in the Upper Puyallup and Mowich Rivers local population for nearly 100 years and has drastically reduced the abundance of migratory bull trout in the Puyallup River. Buckley Diversion and Mud Mountain Dam have significantly affected the White River system in the past by impeding or precluding adult and juvenile migration and degrading foraging, migration, and overwintering habitats in the mainstem. Despite improvements to these facilities, passage related impacts continue today but to a lesser degree.

- Urbanization, road construction, residential development, and marine port development associated with the city of Tacoma, have significantly reduced habitat complexity and quality in the lower mainstem rivers and associated tributaries, and have largely eliminated intact nearshore foraging habitats for anadromous bull trout in Commencement Bay.

- The presence of brook trout in many parts of the Puyallup core area and their potential to increase in distribution, including into Mount Rainer National Park waters, are considered significant threats to bull trout. Because of their early maturation and competitive advantage over bull trout in degraded habitats, brook trout in the upper Puyallup and Mowich River local population are of highest concern because of past isolation of bull trout and the level of habitat degradation in this area.

- Until the early 1990s, bull trout fisheries probably significantly reduced the overall bull trout population within this and other core areas in Puget Sound. Current legal and illegal fisheries in the Puyallup core area may continue to significantly limit recovery of the population because of the low numbers of migratory adults.

- Water quality has been degraded due to municipal and industrial effluent discharges resulting from development, particularly in the lower mainstem Puyallup River and Commencement Bay.

- Water quality has also been degraded by stormwater discharge associated with runoff from impervious surface. Impervious surface in the Puyallup watershed increased by 12 percent between 1990 and 2001 (PSAT 2007).

- Major flood events in November 2006 significantly impacted instream habitats within the Puyallup River system. These events are assumed to have drastically impacted bull trout brood success for the year, due to significant scour and channel changes that occurred after peak spawning. Significant impacts to rearing juvenile bull trout were also likely, further impacting the future recruitment of adult bull trout.

In November 2006, an 18,000 gallon diesel spill in the head waters of Spring Creek (Hebert, in litt. 2006), a bull trout spawning area of the Upper White River local population, likely impacted the available instream spawning habitat. The duration of ongoing contamination of instream habitats by residual diesel is unknown.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Environmental Baseline in the Action Area

This section addresses three topics relevant to our discussion of the environmental baseline: 1) instream habitat conditions along the lower Puyallup River, 2) surface water quality conditions and trends, and 3) current, ongoing operating conditions at the City of Puyallup WWTP.

Instream Habitat Conditions

The lower Puyallup River has been substantially altered, especially throughout its lowermost reaches. The primary factors that have created and continue to influence the current habitat conditions include urban and suburban growth and development, agriculture, heavy industry, flood control, channelization and dredging, and construction of revetments and levees.

The lower Puyallup River, from approximately RM 28 to the mouth of Commencement Bay, has been confined and straightened by channelization (Kerwin and WSCC 1999). The river is separated from its floodplain by a series of dikes, revetments, and levees along both banks, severing and interrupting historic surface water connections. Development of the floodplain has simplified the historic river channel complex, eliminating off- and side-channel habitats.

Dredging of the lower Puyallup River began in the early 1900s, with permanent channelization and flood control efforts (i.e., dikes and levees) following soon afterward (Kerwin and WSCC 1999). These channel modifications have altered the natural hydrology and bedload characteristics, removed sources and accumulations of large wood, and simplified and homogenized instream habitats. At many locations, repeated dredging of the channel and removal of large wood has resulted in a simplified, U-shaped channel lacking deep, complex pool habitat and/or a natural pattern of pool-riffle-run habitats.

Urban and suburban growth and development has also increased the amount of impervious surface, and reduced floodplain storage capacity, throughout the lower watershed. For some tributaries this has resulted in a predictable syndrome, where seasonal peak flows are heightened with a potential for causing channel bed and bank erosion, and base flows are reduced.

Less than 5 percent of the lower reaches of the Puyallup River retain what is characterized as high quality riparian habitat, and much of what remains is fragmented (Kerwin and WSCC 1999). Loss of functioning riparian vegetation and floodplain connectivity, and filling of floodplain and estuarine wetlands, have greatly reduced the amount of habitat which is available to bull trout and other salmonids for rearing and overwintering. These trends have severely degraded the lower river's function as a place where anadromous fish transition between the freshwater and marine environments, and have eliminated refugia which are important to migrating fish.

High levels of fine sediments and substrate embeddedness are considered limiting factors for salmonid spawning and rearing along the lower Puyallup River (Kerwin and WSCC 1999). Puyallup Tribal Fisheries (2005) conducted studies from RM 10.7 to Commencement Bay, found few areas of gravel suitable for spawning, and other areas where substrates were suitable but compacted and/or embedded with fines. These conditions limit the productivity of native fish populations along the lower river. These conditions also limit production of the aquatic macroinvertebrate community, which reduces foraging opportunities for native resident and migratory fish.

This generic description of habitat conditions along the lower Puyallup River fairly and accurately describes conditions with the action area (RMs 5.7 to 6.9). The lower Puyallup River is confined and levied within the action area, side and off-channel habitats are almost completely absent, riparian function is heavily degraded, instream habitats are simplified and homogenized, seasonal peak flows are heightened, and there are few refugia available to migrating and overwintering fish. One minor tributary, Clarks Creek, enters on the left-bank at approximately RM 5.8. Despite similarly degraded conditions, Clarks Creek continues to support salmonid spawning and rearing (EPA 2012a, p. 36). The action area provides foraging, migration, and overwintering (FMO) habitat which is most important as an essential migratory corridor, but which also likely supports some amount of foraging. Bull trout are opportunistic foragers and frequently focus where prey is seasonally abundant and concentrated. It is possible, though not known for certain, that migratory adult and subadult bull trout may forage at the mouth of Clarks Creek when juvenile salmonids are outmigrating and/or when adult salmonids are spawning.

Recent years have seen several habitat restoration activities planned and implemented along the lower Puyallup River, including activities sponsored by the Puyallup Tribe. These activities have created and restored estuarine and intertidal habitats, have set back levees and/or provided fish passage through levees, and have reconnected, created, and/or restored off-channel habitats, wetlands, and refugia. These activities have restored a small fraction of the habitat which was previously lost or unavailable, but their importance cannot be overstated. Given the severely degraded habitat conditions that persist throughout most of the lower river, even small and gradual improvements should help to support stronger and more resilient native fish populations.

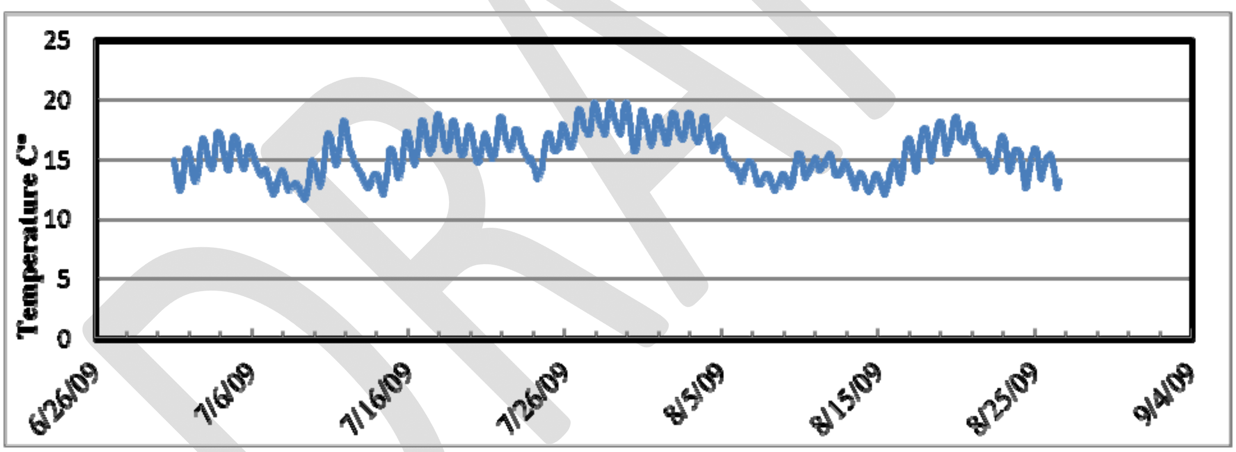
<u>Surface Water Quality Conditions and Trends</u>

Within the action area, the lower Puyallup River exhibits moderately degraded water quality conditions. Ecology's CWA 303(d) list of impaired waterbodies identifies these parts of the Puyallup River as a Category 5 water for two criteria (fecal coliform and mercury), and as a Category 2 water for one additional criteria (dissolved oxygen)(EPA 2012a, p. 28). Category 5 waters are impaired and require a TMDL. Category 2 waters are regarded as waters of concern, where there is some evidence of a water quality problem, but not enough to require a TMDL at this time.

During the 1990s, Ecology determined that a preventative TMDL should be established for the Puyallup River basin in order to ensure that the dissolved oxygen criteria would continue to be met (EPA 2012a, p. 30). This TMDL established the allowable loads for total ammonia (Ammonia-N), BOD_5, and residual chlorine, and determined and assigned wasteload allocations for significant NPDES permit holders. The City of Puyallup WWTP was granted the largest load allocations among the nine or more municipal permits, four or more industrial permits, and hatchery operations which are included in the Puyallup River dissolved oxygen TMDL (WDOE 1994, Appendix Table 9). [Note: to our knowledge, Ecology has not yet begun the process of establishing a mercury TMDL for the Puyallup River; there may be some uncertainty regarding the validity and/or cause for observed criteria exceedances (EPA 2012a, pp. 82-84).]

The EPA has provided summary information to describe the historic range and seasonal pattern of ambient surface water temperatures for the action area (EPA 2012a, pp. 32-34). The 90th percentile water temperature for data collected during the summer months (May – October) between 1990 and 2007 is reported as 15.9 °C. However, additional monitoring data collected during both the summer of 2007 and 2009 document an irregular pattern of occasional, short excursions above 18 °C, with a reported maximum of 19.8 °C. Figure 4 depicts ambient surface water temperatures for the action area, collected between late June and late August 2009.

Figure 4. Water temperature, Puyallup River at Melroy Bridge (EPA 2012a, p. 34).



The EPA has provided summary information to describe ambient dissolved oxygen conditions for the action area (EPA 2012a, pp. 31, 32). The 5th percentile dissolved oxygen concentration is reported as 9.8 mg/L, and the minimum reported for years 1970 through 2007 is approximately 9.1 mg/L.

The EPA has provided summary information to describe ambient ammonia concentrations for the action area (EPA 2012a, pp. 29, 30). The 90th percentile ammonia concentration for data collected between 1990 and 2007 is reported as 40 µg/L total ammonia (Ammonia-N). Based on ambient pH conditions, we would expect that 1 to 1.5 percent of the total ammonia concentration is present as toxic unionized ammonia (NH_3); this translates to 0.4 to 0.6 µg/L unionized ammonia. The maximum total ammonia concentration for the reporting period is approximately 530 µg/L (Ammonia-N) (WDOE 2012), which translates to 5.30 to 7.95 µg/L unionized ammonia.

The EPA has provided summary information to describe ambient dissolved metal concentrations for the action area (EPA 2012a, pp. 42-44). Mean and maximum dissolved copper concentrations for data collected between 2003 and 2010 are reported as 2.04 µg/L and 7.48 µg/L, respectively. Mean and maximum dissolved zinc concentrations are reported as 2.08 µg/L and 6.23 µg/L, respectively. As recently as April 2012, Ecology has documented and reported excursions above the chronic dissolved copper criteria (WDOE 2012).

Operating Conditions at the City of Puyallup WWTP

The EPA provided information in the submitted BE, draft NPDES permit, and fact sheet which allows us to characterize some of the current operating conditions, and performance characteristics, of the City of Puyallup WWTP:

- *Solids Control* – The City of Puyallup WWTP provides an extended solids retention time, and produces treated effluent which contains low to very low TSS concentrations. The treatment processes typically produce effluent ranging between 2 and 4 mg/L TSS (EPA 2012a, pp. 44, 49, 56).

- *Maximum Effluent Discharge Concentrations* – Table 3 summarizes maximum effluent discharge concentrations for select pollutant or parameters, as reported to the EPA through monthly discharge monitoring reports (EPA 2012c, pp. 21, 22). These data make clear that the City of Puyallup WWTP sometimes operates outside of the effluent limitations which the EPA currently proposes to include in Permit No.WA-003716-8 (e.g., pH and total copper parameters).

Table 3. Maximum reported treated effluent discharge concentrations (EPA 2012c, pp. 21, 22).

Pollutant / Parameter	**Maximum Reported Concentration (2003 to 2011)**
Temperature	23.6 °C (Summer) 18.4 °C (Winter)
BOD_5	8.97 mg/L (Monthly Average)
TSS	12.41 mg/L (Monthly Average)
pH	6.3 – 7.6
Fecal Coliform	57 colonies/100 mL
Ammonia (Ammonia-N)	9.25 mg/L (Daily Maximum)
Copper (Total Recoverable)	20.9 µg/L (Daily Maximum)
Mercury (Total Recoverable)	0.02 µg/L (Daily Maximum)
Zinc (Total Recoverable)	72.04 µg/L (Daily Maximum)

- *Whole Effluent Toxicity* – The City performs and reports the results of annual Whole Effluent Toxicity testing. The EPA has stated that this acute and chronic testing consistently demonstrates "… no reasonable potential to cause or contribute to exceedances of water quality standards" (EPA 2012c, p. 12).

- *Effluent Plume Dynamics* – The EPA used a two-dimensional model, ambient water quality data, and 99th percentile effluent data to conservatively assess and describe mixing and dilution within the allowable acute and chronic mixing zones (EPA 2012a, pp. 10-13). For most pollutants or parameters, mixing and dilution quickly reduce concentrations after discharge. Modeled concentrations for most parameters decline to within 5 percent of the ambient or background concentration within the allowable acute mixing zone (i.e., at a distance of less than 30 ft). Results indicate that two modeled pollutants or parameters, zinc and ammonia, are likely to persist at elevated concentrations to a substantially greater distance downstream of the point of discharge. Model outputs suggest that zinc concentrations decline to within 5 percent of the ambient or background concentration at a distance of approximately 300 ft, and ammonia concentrations decline to within 5 percent of the ambient or background concentration at a distance of approximately 1.2 miles downstream (EPA 2012a, p. 13).

- *Removal of Emerging or Unconventional Contaminants* – The EPA has summarized results from a study investigating the removal of conventional pollutants, pharmaceuticals, hormones, natural and synthetic endocrine disruptors, and other organic compounds at five municipal WWTPs from around the Puget Sound region (Lubliner et al. 2010), including the City of Puyallup WWTP (EPA 2012a, pp. 44-51). The City of Puyallup WWTP was found to remove approximately 99 percent of the influent TSS, 83 percent of the influent ammonia, and many of the endocrine disrupting compounds (EDCs) typically found in secondary treated effluent. Treatment processes employed at the City of Puyallup WWTP successfully breakdown and remove numerous compounds that would otherwise be discharged with the treated effluent (EPA 2012a, pp. 44, 49). Many of the hormones and phthalates are removed to undetectable levels. The natural and synthetic reproductive hormones estradiol, ethynyl estradiol, and 17a-estradiol are all removed at 85 to 95 percent of their influent concentrations, resulting in undetectable levels of less than 2 parts per trillion (EPA 2012a, p. 48). These compounds are ubiquitous in the environment (Kolpin et al. 2002), and biologically active at exceedingly low concentrations. Removal of these compounds from the treated effluent is significant, since they are frequently responsible for observed endocrine disruption in exposed fish (EPA 2012a, p. 48).

Status of the Species in the Action Area

The lower Puyallup River is formed by the merging of three major watersheds, the White, Carbon, and upper Puyallup Rivers. The Puyallup River core area's five local bull trout populations spawn and rear in the upper portions of these watersheds. The mainstem White, Carbon, and Puyallup Rivers provide freshwater FMO habitats which are important to foraging and migrating bull trout. Habitats along the lower Puyallup River support all of the core area's natal anadromous bull trout, and perhaps some fluvial individuals. The lower Puyallup River provides FMO habitats which are essential to these anadromous bull trout. The Puyallup River core area's anadromous bull trout forage and migrate along the lower Puyallup River when making seasonal movements to and from the marine waters.

Adult bull trout migrate through the lower Puyallup River and action area during the months of June through August of most years, reaching their spawning grounds in the upper watersheds by September (Chan 2011, personal communication). Most years, subadults begin downstream movements in pursuit of foraging opportunities during late winter (Chan 2011, personal communication).

Based on past observations and recent telemetry work (Deming, pers comm 2006; Jeanes, pers comm 2006), bull trout using the lower Puyallup River appear to focus on the outlets of tributary streams when foraging and seeking thermal refugia. Given the degraded nature of the lower Puyallup River, such areas may provide critical "stepping-stones" during migration.

Based on low returns observed at the Buckley Diversion, and perhaps due in part because upstream passage at Electron Dam was only recently restored, it appears that only a limited number of migratory, fluvial and anadromous bull trout use FMO habitats along the lower Puyallup River. Only the Carbon River local populations benefit from full, unencumbered connectivity between the upper watershed's spawning and rearing habitats, and the lower river and marine waters of Commencement Bay.

Recent Buckley Diversion trap counts document larger numbers of bull trout using lower portions of the watershed. Counts have increased, from a running-average of approximately 50 fish, to approximately 80 or 90 fish during recent years. This increase suggests that numbers within some local bull trout populations are stable, or possibly increasing. Migratory bull trout are periodically captured in the terminus forebay of the Electron Dam's diversion flume/canal (Fransen 2005), indicating that some individuals from this part of the system still express fluvial and perhaps anadromous life histories.

The action area provides FMO habitats which are essential to the Puyallup River core area's anadromous bull trout. These habitats also support the Puyallup River's native salmon and steelhead trout populations, which represent important prey resources for bull trout of the Puget Sound Management Unit. The Service expects that low numbers of adult and subadult bull trout may occupy the action area at any time of year, although the numbers present most likely peak between the months of April and August. Information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area. Individuals in the action area likely originate from all five of the Puyallup River core area's local populations.

Status of Critical Habitat in the Action Area

The Service's recent final rulemaking revises the previous (2005) bull trout critical habitat designation (50 FR 63898 [October 18, 2010]). This final rule took effect on November 17, 2010. The Service excluded the 1873 survey area of the Puyallup Reservation (RMs 1.0 and 7.3) when designating bull trout critical habitat. We expect that the action will have no measurable adverse effects to designated bull trout critical habitat located downstream of the Reservation.

Conservation Role of the Action Area

The action area provides core FMO habitat for bull trout. FMO habitat is important to bull trout of the Puget Sound Management Unit for maintaining diversity of life history forms and for providing access to productive foraging areas. Habitats along the lower Puyallup River support all of the Puyallup River core area's natal anadromous bull trout, and perhaps some fluvial individuals. These habitats also support the Puyallup River's native salmon and steelhead trout populations, which represent important prey resources for bull trout of the Puget Sound Management Unit.

The Service expects that low numbers of adult and subadult bull trout may occupy the action area at any time of year, although the numbers present most likely peak between the months of April and August. Information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area.

Effects of Past and Contemporaneous Actions

The Service has previously issued Opinions and granted incidental take for actions adversely affecting bull trout of the Puyallup River core area. In each case we determined that these actions are not likely to jeopardize the continued existence of the bull trout. Nevertheless, the combined effects of these past and contemporaneous Federal actions have resulted in short and long term adverse effects to bull trout and, in some instances, an incremental degradation of the environmental baseline.

EFFECTS OF THE ACTION

Regulations implementing the Act define the "effects of the action" as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline" (50 CFR Section 402.02). This section details the anticipated effects of the proposed action on the bull trout.

The EPA proposes to reissue a NPDES permit for continued operation of the City of Puyallup WWTP. The proposed NPDES permit would have a term of five years from the effective date (2012-2017). The City of Puyallup WWTP provides secondary treatment for domestic and pre-treated industrial wastewaters, and discharges to the lower Puyallup River within the 1873 survey area of the Puyallup Reservation.

The proposed action will not create or provide additional WWTP capacity. The action will have no foreseeable indirect effects to the pattern or rate of land use conversion or development. Biosolids management and disposal are regulated under a separate permit (EPA 2012c, p. 10), and therefore the sites and/or facilities where biosolids are processed and disposed are not included in the action area.

The EPA has demonstrated that the plant's effluent plume becomes completely mixed, such that there is no measurable difference from background for the most conservative indicator, at a distance of approximately 1.2 miles downstream (EPA 2012a, pp. 10-13). Therefore, the action area includes the City of Puyallup WWTP, the existing outfall pipe and diffuser located waterward of the Puyallup River's left-bank, and the bed and banks of the lower Puyallup River, extending from the point of discharge (RM 6.9) a distance of approximately 1.2 miles downstream, and 100 ft upstream (RMs 5.7 to 6.9).

Continued operation of the City of Puyallup WWTP will result in measurable adverse effects to bull trout, their habitat, and prey resources. Discharge of treated and disinfected wastewater from the City of Puyallup WWTP causes and contributes to degraded surface water quality conditions within the action area. These degraded surface water quality conditions are a source of metabolic stress for exposed bull trout, and may at times measurably and significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and shelter).

The best available science leads us to conclude that sub-lethal exposures to elevated temperature, unionized ammonia, and dissolved metals (copper and zinc) are likely to cause measurable adverse effects in some bull trout, and to bull trout prey resources within the action area. Measurable adverse effects to individuals may at times include an avoidance response which prevents or discourages free movement through the action area, increased metabolic stress, reduced locomotor performance, and impaired olfactory responsiveness. These adverse exposures and effects may compromise the growth, long-term survival, and reproductive potential (or fecundity) of some bull trout individuals. Not least of all because the Puyallup River core area's anadromous bull trout are exposed repeatedly to these degraded conditions when making annual migrations through the action area.

Whether considered in isolation or in combination, these degraded surface water quality conditions, and the possibility of sub-lethal exposures and effects, act to further impair habitat function within the action area. Baseline environmental conditions are moderately to severely impaired, and bull trout using the lower Puyallup River are challenged by the lack of instream habitat complexity and cover, side- and off-channel habitat, thermal refugia, and transitional estuarine habitat between the freshwater and marine environments.

These same adverse effects to individuals and to habitat have significance for the size and health of the bull trout prey base. Degraded baseline conditions limit productivity of the Puyallup River's native salmon and steelhead trout populations and discharges from the City of Puyallup WWTP add incrementally to this degraded baseline.

The sub-sections that follow discuss reasonably foreseeable adverse effects to bull trout, their habitat, and prey resources. We emphasize the measurable, adverse, sub-lethal exposures and effects, including exposures to elevated temperature, unionized ammonia, and dissolved metals (copper and zinc). We also discuss additive and synergistic effects, the wide variety of emerging and unconventional wastewater pollutants of concern (e.g. natural and synthetic endocrine disruptors), and the significance of wastewater pollutant loadings.

Wastewater Pollutants as Environmental Stressors

This sub-section provides background information regarding wastewater pollutants of concern, including information to explain how pollutants act as stressors when released to the aquatic environment.

<u>Conventional Pollutants and Parameters</u>

The effluent limitations established by the EPA for the proposed permit include a technology-based limit for TSS and water quality-based effluent limitations for BOD_5, fecal coliform bacteria, total ammonia (or Ammonia-N), total copper, and pH. In addition to these conventional pollutants for which the permit will include effluent limitations, this sub-section also discusses two other conventional pollutants or parameters (temperature and zinc).

Temperature

Temperature is the most important abiotic factor influencing metabolic rate in fish and other ectotherms (Barnes et al. 2011, p. 397). As temperature increases towards the thermal tolerance limit, metabolic rate increases exponentially, sometimes with consequences for growth. With increasing water temperatures, oxygen solubility is lowered and fish must also contend with reduced dissolved oxygen levels (Barnes et al. 2011, p. 397).

Bull trout are noted for their association with cold water, and temperature has been identified as an important limiting factor for the species (Howell et al. 2010, p. 96). Investigating the influence of temperature and other environmental variables on the distribution of small, resident and/or juvenile bull trout at the southern margin of their range, Dunham et al. (2003, pp. 894, 900, 901) found that maximum daily temperature was a statistically significant and strong predictor of the probability of occurrence. At maximum daily temperatures above 16 °C, predicted probabilities of occurrence become increasingly low.

Selong et al. (2001, p. 1026) have investigated the effect of temperature on growth and survival of young bull trout, and their results demonstrate that young bull trout exhibit a lower upper thermal limit and growth optima compared to most other North American salmonids. After 60-day chronic exposures, survival of age-0 bull trout was at least 98 percent at 8, 10, 12, 14, 16, and 18 °C, but was 0 percent at 22, 24, 26, and 28 °C. Selong et al. (2001, pp. 1026, 1027) report upper incipient lethal temperatures, the temperatures at which mortalities are approximately 50 percent, of 20.9 °C and 23.5 °C for 60-day and 7-day chronic exposures, respectively. Peak growth occurred at 13.2 °C, feed consumption declined significantly at temperatures greater than 16 °C, and fish held at temperatures of 22 °C and higher did not feed. Metabolic efficiencies (i.e., feed, lipid, and protein conversion efficiencies) were similar across the range of 8 to18 °C, but declined significantly at 20 °C. Reduced growth and feed consumption, both of which are considered sub-lethal responses indicative of thermal stress, were first detected at 15.9 °C and 16.3 °C, respectively (Selong et al. 2001, p. 1033). The authors state that "…metabolic costs rise exponentially with temperature"; at temperatures greater than 18 °C young bull trout exhibited significantly reduced food consumption, growth, and feed conversion efficiency, and "…exhibited outward signs of stress suggesting that extended exposure to elevated temperatures would rapidly deplete their energy reserves." (Selong et al. 2001, p. 1033)

These and other field and laboratory studies document bull trout sensitivity to temperature. However, there is also a growing body of literature which demonstrates variation in thermal tolerance among salmonid populations adapted to differing temperature regimes (Barnes et al. 2011; Cooke et al. 2012; Eliason et al. 2011). And it has long been recognized, both that thermal tolerances appear to differ among bull trout at different life stages, and that migratory bull trout frequently experience and tolerate temperature maximums that substantially exceed their optima (Baxter 2002; Buchanan and Gregory 1997; Fraley and Shepard 1989; Homel and Budy 2008; Rieman and McIntyre 1993; Rieman and McIntyre 1995; Rieman et al. 1997; Swanberg 1997).

Salmonids are considered "metabolic conformers", they exhibit a metabolic rate that is dependent upon environmental conditions, and therefore they are commonly understood to be less tolerant of high temperatures and/or hypoxia (i.e., a condition of reduced dissolved oxygen availability)(Barnes et al. 2011, p. 397). Barnes et al. (2011), Cooke et al. (2012), and Eliason et al. (2011) have investigated environmental tolerances in sockeye (*Oncorhynchus nerka*) and Atlantic (*Salmo salar*) salmon. Their research documents physiological adaptation to high temperatures and/or hypoxia at the level of the population or stock. Individuals from populations that have experienced more variable and/or physiologically challenging environments appear to exhibit a greater capacity for metabolic regulation. This research suggests that salmonids are not strict "metabolic conformers", and would indicate that thermal tolerance is a complex adaptive response that varies between populations.

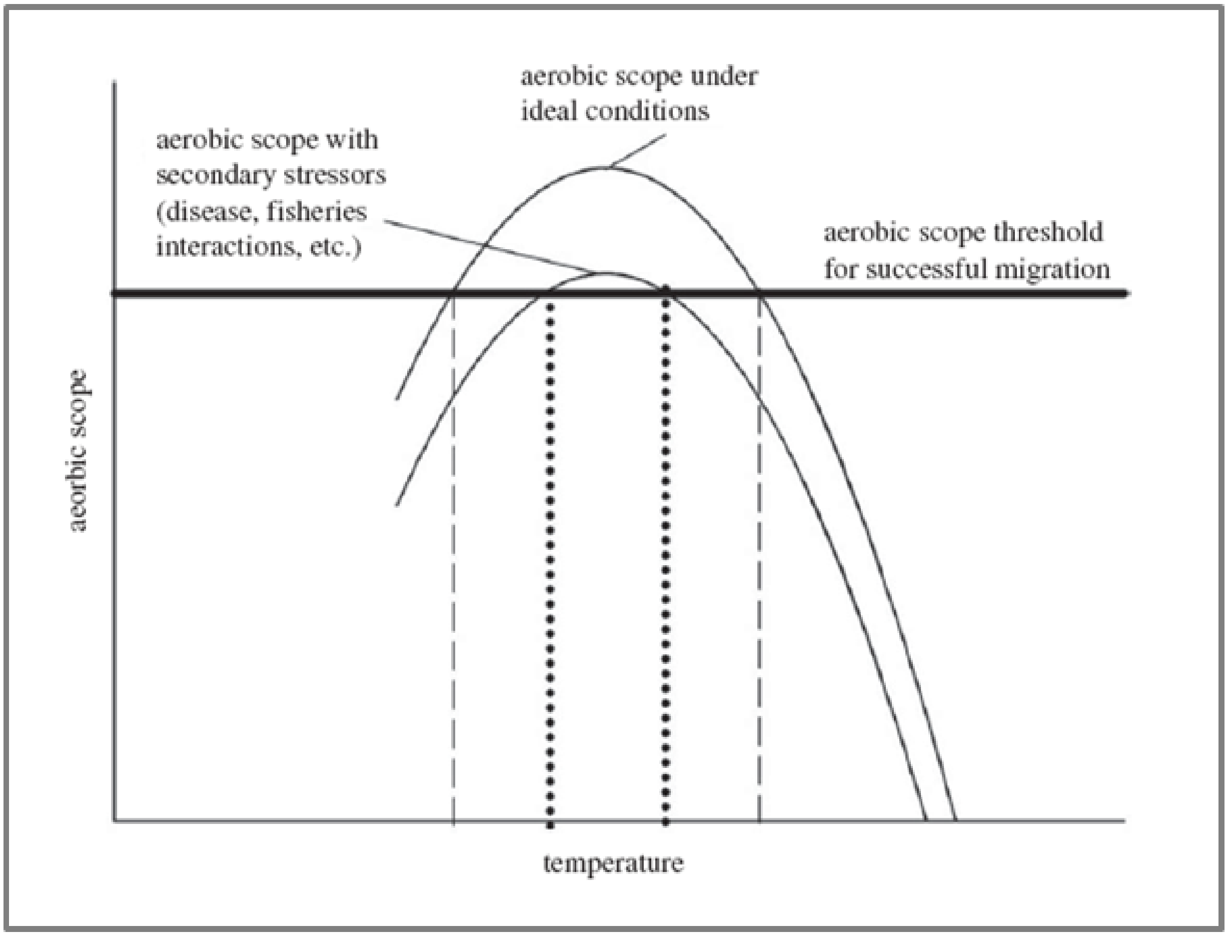
Cooke et al. (2012) and Eliason et al. (2011) examined variation in aerobic scope among sockeye salmon populations from the Fraser River (British Columbia, Canada) and its significance for migration through a complex and challenging set of riverine environments. Aerobic scope, the difference between resting and maximum oxygen consumption rates, varies among individuals and would appear to explain a corresponding variation in the tolerance for a thermally and hydraulically challenging environment. Eliason et al. (2011, p. 111) state that "…upstream migration is clearly impossible at T_{crit} [(i.e., when aerobic scope is zero), but] exactly how much scope is required for successful river migration is unknown." Cooke et al. (2012, p. 1763) state that "even though the exact cause of temperature-induced mortality is unknown, the aerobic challenge of up-river migration … appears to be a significant bottleneck when river temperatures are warmer than normal." Each individual's aerobic scope places an upward limit on the delivery of oxygen for locomotion and other basic functions.

Cook et al. (2012, pp. 1758, 1764) have emphasized that environmental stressors rarely act alone and the authors provide a useful graphic illustrating aerobic scope, both as a function of temperature under ideal conditions and under the influence of secondary stressors (Figure 5):

> "For a given salmon population, there is a minimum aerobic scope threshold for successful migration to reach the spawning ground. This threshold will vary yearly depending on environmental conditions (e.g. may increase or decrease due to varying river flow, etc.). The optimal range of temperatures is restricted when fish are physiologically compromised due to secondary stressors (dotted lines)."

Howell et al. (2010) studied spatial and temporal patterns of thermal habitat use by migratory adult bull trout. Tagged fish routinely experienced 7-day average daily maximums within the range of 18 to 25 °C and there was no apparent use of cold water thermal refuges. The authors state, "in spite of potential physiological consequences, bull trout … sometimes used relatively warm waters even when cooler water was available upstream." (Howell et al. 2010, p. 103)

Figure 5. Aerobic scope under the influence of temperature and other stressors (Cooke et al. 2012, p. 1764).



Biochemical Oxygen Demand

BOD_5, or 5-day biochemical oxygen demand, is a standardized methodology for assessing oxygen consumption resulting from bacterial decomposition of organic material. The measure is of limited value in and of itself, but can be used in conjunction with other parameters (e.g., temperature, nutrient levels) to evaluate what effect effluent discharges may have on dissolved oxygen concentrations in the receiving waterbody. Dissolved oxygen, or oxygen saturation, is a relative measure of the amount of available oxygen. Both BOD_5 and dissolved oxygen are generally measured and reported in mg/L, or parts per million.

Dissolved oxygen is essential to the health and function of aquatic ecosystems. In freshwater systems, oxygen concentrations and availability are primarily influenced by temperature and rates of consumption and replenishment. Rates of consumption and replenishment are dependent upon or influenced by the community of respiring (i.e., oxygen-consuming) organisms, the community of photosynthesizing (i.e., oxygen-producing) organisms, benthic and bacterial processes (including decomposition of dissolved and particulate organic material), and other atmospheric, climatological, and physical processes (e.g., mixing and stratification). At 8 °C and

95 percent saturation, dissolved oxygen concentrations are approximately 12 mg/L. At water temperatures in excess of 20 °C, dissolved oxygen concentrations may drop to 6 mg/L or lower.

Under Washington State law, freshwater dissolved oxygen criteria are specified for several aquatic life categories (W.A.C. 173-201A-200): char spawning and rearing (9.5 mg/L), core summer salmonid habitat (9.5 mg/L), salmonid spawning, rearing, and migration (8.0 mg/L), etc. The Puyallup Tribe's WQS establish a single criterion for freshwaters (8.0 mg/L)(EPA 1994).

It is widely known that low or extremely low dissolved oxygen concentrations are a common cause for fish kills. However, there is less appreciation for the significant sub-lethal effects that can result from exposure to hypoxic conditions. Kramer (1987) has provided a useful summary review of fish behavioral responses to dissolved oxygen availability. As with exposure to high temperatures, exposure to hypoxic conditions frequently imposes a metabolic cost that results in less energy being available for locomotion and other basic functions which are important to growth and survival. Oxygen concentration indicates the "… amount of medium which must be ventilated in order to obtain a given amount of oxygen", and the increased ventilation rates that are required under hypoxic conditions place a burden on metabolic and energetic reserves (Kramer 1987, pp. 83, 85). Both sustained swimming and effective escape movements also place demands on energy, and therefore predator avoidance and locomotion may be compromised under conditions of low dissolved oxygen availability (Kramer 1987, p. 85).

The Canadian Ministry of Natural Resources considered the implications of aerobic scope (or "scope-for-activity") when evaluating dissolved oxygen criteria for the protection of lake trout (*Salvelinus namaycush*) habitat (Evans 2006). The metabolic energy available to support daily movements, prey capture, predator avoidance, and migration is unconstrained by dissolved oxygen concentrations that exceed the "threshold for respiratory dependence" (Evans 2006, pp. 3-6). Evans (2006, pp. 5-8) reports that lake trout scope-for-activity is 100 percent at 8.1 mg/L dissolved oxygen and 14 °C, and at 7.7 mg/L dissolved oxygen and 18 °C. Growth studies conducted with six different salmonid species suggest that significant impacts to bioenergetics would begin to occur at dissolved oxygen concentrations below 7.0 mg/L (Evans 2006, p. 11).

Ammonia

Ammonia occurs naturally in surface waters, it is highly soluble in water, and its speciation is influenced by a wide variety of environmental parameters, including pH, temperature, and ionic strength (EPA 2012a, p. 57). In aqueous solutions, an equilibrium exists between unionized (NH3) and ionized (NH4 +) ammonia species. Unionized ammonia refers to all forms of ammonia in water with the exception of the ammonium ion (NH4 +). Unionized ammonia is toxic to fish and other aquatic life. Unionized ammonia may be toxic because it passes through biological membranes more readily (EPA 2012a, p. 57). Based on ambient pH conditions, toxic unionized ammonia (NH_3) should be present at concentrations that approximate 1 to 1.5 percent of the total ammonia (Ammonia-N) concentration.

When reporting their decision regarding adoption of new chronic ammonia criteria, Ecology expressed uncertainty regarding the protectiveness of the EPA's recommended criteria (WDOE 2002, p. 2). Ecology cited the work of Arillo et al. (1981), which found that "…concentrations of unionized ammonia less than 20 μg/L … cause changes in biochemical parameters related to brain, kidney, and liver metabolism." Ecology stated, "… although rarely used in criteria development … [these] subtle effects … may be of significance to salmonids in the Pacific Northwest." (WDOE 2002, p. 10)

The Service has previously identified low concentrations of unionized ammonia as a source of measurable adverse effects (Biological Opinion – City of Arlington WWTP, Ref. No. 13410-2009-F-0175). Here the Service relied on the work of Wicks et al. (2002), in finding that unionized ammonia concentrations over 40 μg/L may cause adverse exposures and effects to individuals (Opinion pp. 48-51, 74, 75).

The work of Wicks et al. (2002), Shingles et al. (2001), and others, presents evidence of measurable, sub-lethal effects resulting from unionized ammonia exposure with potential consequences for growth, survival, and reproduction. McKenzie et al. (2007) have provided a useful review and synthesis of these findings. While some findings suggest the link between ammonia exposure and reduced critical swimming speed reflects competing whole-body metabolic needs, McKenzie et al. (2007, p. 59) claim "…there is [also] now good evidence to indicate that exposure to sub-lethal concentrations of ammonia impairs the function of white muscle." McKenzie et al. have offered a useful explanation for the biological relevance of these exposures. If ammonia exposures result in depolarisation of white muscle, fish may be incapable of achieving the swimming speeds necessary to "negotiate velocity barriers" or find refuge from "seasonal storms and floods." (McKenzie et al. 2007, p. 59)

Fecal Coliform Bacteria

Fecal coliform bacteria is an indirect measure or indicator parameter for possible sewage contamination (EPA 2012d). Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, surface waters and effluent discharges are usually tested for coliforms instead. Although generally not harmful themselves, these coliforms indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans (EPA 2012d).

Copper

Even at low concentrations, copper is acutely toxic to fish. Effects of exposure to copper include 1) weakened immune function and impaired disease resistance, 2) impaired respiration, 3) disruptions to osmoregulation, 4) impaired function of olfactory organs and brain, 5) altered blood chemistry, 6) altered enzyme activity and function, and 7) pathology of the kidneys, liver, and gills (Eisler 1998).

The acute lethality of copper has been evaluated for bull trout. Hansen et al. (2002) examined acute toxicity and determined that rainbow trout fry and bull trout fry have similar sensitivities. The authors describe a 96-hour and 120-hour LC50 for bull trout under test conditions (100 mg/L hardness and 8 ºC), approximately 66.6 and 50.0 μg/L, respectively.

Baldwin et al. (2003) found that short pulses of dissolved copper, at concentrations as low as 2 µg/L, reduced olfactory sensory responsiveness by approximately 10 percent within 10 minutes, and by 25 percent within 30 minutes. At 10 µg/L responsiveness was reduced by 67 percent within 30 minutes. Baldwin et al. (2003) identified a copper concentration neurotoxic threshold of an increase of 2.3 to 3.0 µg/L, when background levels are 3.0 µg/L or less. When exceeded, this threshold is associated with olfactory inhibition. The authors also reference three other studies examining long-duration copper exposures (i.e., exceeding 4 hours); these studies found that long-duration exposures resulted in cell (olfactory receptor neuron) death in rainbow trout and Atlantic and Chinook salmon. Baldwin et al. (2003) found that water hardness did not influence the toxicity of copper to coho salmon sensory neurons.

More recently, Sandahl et al. (2007) documented sensory physiological impairment, and related disruption to predator avoidance behaviors, in juvenile coho at concentrations as low as 2 µg/L dissolved copper.

The effects of short-term copper exposure may persist for hours and possibly longer. Although salmonids may actively avoid surface waters containing an excess of dissolved copper, exposed individuals may experience olfactory function inhibition. Avoidance of a chemical plume may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. This, in turn, can make fish more vulnerable to predation and can impair foraging success, feeding efficiency, and thereby growth.

Folmar (1976) observed avoidance responses in rainbow trout fry when exposed to a Lowest Observed Effect Concentration of 0.1 µg/L dissolved copper (hardness of 90 mg/L). The EPA (1980a) also documented fry avoidance of dissolved copper concentrations as low as 0.1 µg/L during a 1 hour exposure, as well as a LC10 for smolts exposed to 7.0 µg/L for 200 hours, and a LC10 for juveniles exposed to 9.0 µg/L for 200 hours.

Zinc

Zinc occurs naturally in the environment and is an essential trace element for most organisms. However, in sufficient concentrations and when bioavailable for uptake by aquatic organisms, excess zinc is toxic. Toxicity in the aquatic environment and for exposed aquatic organisms is influenced by water hardness, pH, organic matter content, levels of dissolved oxygen, phosphate, and suspended solids, the presence of mixtures (i.e., synergistic effects), trophic level, and exposure frequency and duration (Eisler 1993). Bioavailability of zinc increases under conditions of high dissolved oxygen, low salinity, low pH, and/or high levels of inorganic oxides and humic substances. Most of the zinc introduced into aquatic environments is eventually partitioned into sediments (Eisler 1993).

Effects of zinc exposure include 1) weakened immune function and impaired disease resistance (Ghanmi et al. 1989), 2) impaired respiration, including potentially lethal destruction of gill epithelium (Eisler 1993), 3) altered blood and serum chemistry, and enzyme activity and function (Hilmy et al. 1987a; Hilmy et al. 1987b), 4) interference with gall bladder and gill metabolism (Eisler 1993), 5) hyperglycemia, and 6) jaw and branchial abnormalities (Eisler 1993).

Hansen et al. (2002) determined 120-day lethal concentrations of zinc for test subjects that included bull trout and rainbow trout fry. Multiple pairs of tests were performed with a nominal pH of 7.5, hardness of 30 mg/L, and at a temperature of 8 °C. Bull trout LC50 values measured under these conditions ranged from 35.6 to 80.0 µg/L, with an average of 56.1 µg/L. Hansen et al. (2002) found that rainbow trout fry are more sensitive to zinc (i.e., exhibit a lower LC50) than are bull trout fry. The authors also report that older, more active juvenile bull trout are more sensitive than younger, more docile juvenile bull trout based on observed changes in behavior at the juvenile life stage. The authors argue that the timing of zinc and cadmium exposure and the activity level of the exposed fish are germane to predicting toxicity in the field.

The mode of action for zinc toxicity relates to net loss of calcium. Studies suggest that zinc exposure inhibits calcium uptake, although it appears this effect is reversible once fish return to clean water. The apparent difference in sensitivity between rainbow trout and bull trout may be due to the lesser susceptibility of bull trout to calcium loss. Hansen et al. (2002) state that differences in sensitivity between these two salmonids may reflect different physiological strategies for regulating calcium uptake. These strategies may include gills that differ structurally, differences in the mechanisms for calcium uptake, and/or variation in resistance to or tolerance for calcium loss.

There are no known studies or data describing adult bull trout response to lethal or near-lethal concentrations of zinc. Active feeding and increased metabolic activity are apparently related to sensitivity. It is unknown whether sensitivity to zinc varies between adult, subadult, and juvenile bull trout. Activity level may be a better predictor of sensitivity than age.

In addition to the physiological effects of zinc exposure, studies have also documented a variety of behavioral responses. Among these, Eisler (1993) includes altered avoidance behavior, decreased swimming ability, and hyperactivity. The author also suggests zinc exposure has implications for growth, reproduction, and survival.

Sub-lethal endpoints have been evaluated with test subjects that include both juvenile and adult rainbow trout (Eisler 1993; USEPA 1980b; USEPA 1987). Some of these test results clearly indicate that juvenile rainbow trout are more sensitive than adult rainbow trout. Using juvenile rainbow trout as test subjects, studies have found that sub-lethal effects occur at concentrations approximately 75 percent lower (5.6 µg/L) than the concentrations that result in lethal effects (24 µg/L) (Eisler 1993; Hansen et al. 2002). Sprague (1968) found that at concentrations as low as 5.6 µg/L juvenile rainbow trout exhibit avoidance behavior. Avoidance of a chemical plume may cause fish to leave refugia or preferred habitats in favor of less suitable or less productive habitats. This can make fish more vulnerable to predation and can impair foraging success, feeding efficiency, and thereby growth.

pH

Hydrogen ion (H +) concentration, or pH, is a measure of acid-base equilibrium. In unimpaired surface waters pH typically ranges between 6.5 and 8.5.

Changes in pH affect the disassociation of weak acids and bases, and thereby influence the bioavailability and toxicity of many compounds (EPA 2012a, p. 60). For freshwater ecosystems, the primary concern is that changes in pH can substantially affect the chemical forms and toxicity of other substances. For example, the acute toxicity of ammonia has been found to increase as pH decreases. Hydrogen ion concentration affects the solubility of metal compounds, and pH thereby influences the bioavailability and toxicity of dissolved metals (EPA 2012a, p. 60).

Total Suspended Solids

Some pollutants and contaminants of concern have a strong affinity for suspended solids and the particulate-phase or fraction of discharged effluent (Grant et al. 2003; Wong et al. 2000). As a result, a portion of the toxic, inorganic and non-polar organic contaminant load is in particulate form, either sorbed onto, or complexed with solids (Fan et al. 2001; Grant et al. 2003, pp. viii, x; Marsalek et al. 1999, p. 34; Muthukrishnan and Selvakumar 2006, pp. 2, 5; Wong et al. 2000, p. 11). Pollutant loads bound or complexed with the particulate-phase or fraction represent a persistent, long-term source of potential chronic exposures.

The heavy metals, especially copper, chromium, lead, and nickel are closely associated with the particulate fraction (Grant et al. 2003, p. 5-7; Wong et al. 2000, p. 32); zinc and cadmium to a somewhat lesser extent. Polybrominated diphenyl ethers (PBDEs), polycyclic aromatic hydrocarbons (PAHs), oils and petroleum hydrocarbons generally, and other non-polar organic contaminants, such as pesticides and their decomposition products, are also closely associated with the particulate-phase or fraction. For these and other reasons, some experts in the field have identified TSS as an appropriate indirect measure or indicator of toxic contaminant load (Grant et al. 2003, p. 1-4; Hallberg et al. 2007, p. ab). Where sampling and monitoring are concerned, TSS is a decidedly easier and cheaper parameter to sample and measure.

Particle size distribution exerts a strong influence on contaminant-particulate dynamics and association. Heavy metals, PAHs, and other non-polar organic contaminants are generally bound in greatest concentration to the smallest of particles and colloids. For non-polar organic contaminants, particulate organic matter content also exerts a strong influence, but total particulate surface area is probably of greater significance. The smallest particles have the greatest "surface area to volume ratio", and therefore provide a comparatively larger total surface area to which contaminants may bind, sorb, and complex (Fan et al. 2001; Herngren et al. 2005, p. 150; John and Leventhal 1995, p. 13; Pettersson 2002, p. 1).

Pollutant loads bound or complexed with the particulate-phase or fraction represent a persistent, long-term source of potential chronic exposures and effects (Chen et al. 1996, p. ab; Fan et al. 2001; Glenn et al. 2002, p. 2; Grant et al. 2003, p. 4-3; Pettersson 2002, p. 1). Heavy metals do not degrade in the environment (Glenn et al. 2002, p. 2; Muthukrishnan and Selvakumar 2006, p. 2), and organic contaminants easily persist for durations that exceed the life spans of individual fish or multiple generations of fish (Heintz et al. 2000, p. 214). Chronic effects to individuals stem from repeated exposures over time, through multiple exposure pathways, and from multiple stressors and combinations of stressors (Burton et al. 2000, p. ab; Ellis 2000, p. 86; Heintz et al. 2000, p. 214). Ellis (2000, p. 89) has argued that sediment-mediated exposures and effects have not yet been given adequate attention, and furthermore that "…procedures for the identification of chronic, sub-lethal no effects limits are still to be achieved." Emphasizing the tendency for accumulation in sediments, both Hodson (1988, p. ab) and Pettersson (2002, p. 1) have argued that loads and not simply water concentrations should be a focus for management where discharges of metals and persistent organic pollutants are concerned.

Solids can act as both sinks and sources for metals and non-polar organic contaminants. Contaminants are "…reversibly bound to suspended particles….", and these particles can act as a "…source of water column toxicity or interstitial (pore) water toxicity." (Grant et al. 2003, p. 4-3) Adsorption and complexation are physiochemical processes that would tend to remove contaminants from the liquid-phase and sequester them in the solid-phase (Lloyd 1987, p. 491, 499). Redox potential (i.e., oxidizing or reducing conditions) and pH influence how contaminants are bound and, under varying conditions, can act to either keep contaminants bound in the solid-phase, or conversely, to release or desorb contaminants to the dissolved (liquid) phase (Bostick et al. 1998, p. 1; John and Leventhal 1995, p. 13). Some contaminated sediments constitute a persistent, continuing source of toxic contamination (Fan et al. 2001).

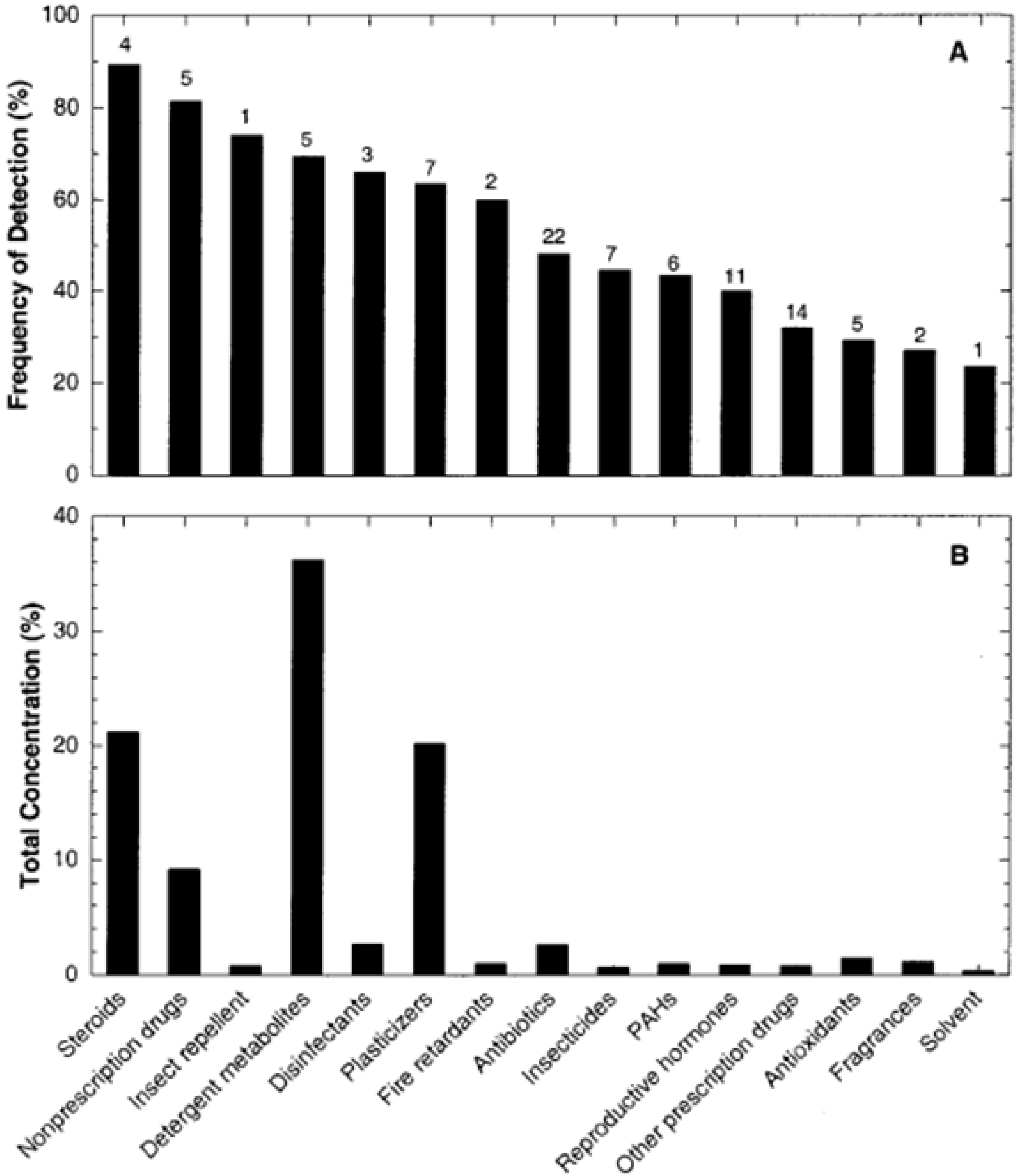
Ambient conditions determine whether contaminated sediments will act as continuing sources or sinks for toxic metals and non-polar organic contaminants. Because ambient conditions are dynamic and can change over time and space, equilibrium levels of metals and organic contaminants in sediments, in interstitial/pore water, and the water column, are also variable. "Bioavailability is a complex function of many factors ... Many of these factors vary seasonally and temporally, and most factors are interrelated." (John and Leventhal 1995, p. 10) Changes in ambient water and sediment chemistry, including redox state, dissolved oxygen concentration, pH, temperature, and buffering capacity/carbonate concentration/hardness, can release sequestered contamination to interstitial pore water or the water column (Chen et al. 1996, p. ab; Marsalek et al. 2002, p. 7; Muthukrishnan and Selvakumar 2006, p. 10; Wong et al. 2000, p. 10).

In fluvial environments, hydrology and fine and coarse sediment dynamics also exert a strong influence on patterns of sediment contamination. Rhoads and Cahill (1999, p. ab) describe variation in levels of sediment metal contamination reflecting distance from the source (outfalls), reach-scale variation in geomorphic conditions, and the degree of bed material sorting. Foster and Charlesworth (1996, p. ab) and Marsalek et al. (2002, pp. ab, 9) also emphasize the role of sediment deposition, accumulation, and remobilization. Baun et al. (2003, p. 4-4) and Chen et al. (1996, p. ab) suggest that hydraulic resuspension of contaminated sediments, and sporadic disturbance and release of contaminated interstitial pore water, influences bioavailability. Ellis (2000, p. 86) has argued that understanding the "…probability of biotic uptake and ecosystem response … requires incorporation of water quality effects with impacts on sediment and pore waters as well as habitat impairments resulting from flow hydraulics."

<u>Unconventional Pollutants and Emerging Contaminants</u>

Unconventional wastewater contaminants have been a focus of intense study over the past decade. Pollutants associated with wastewater are ubiquitous in U.S. waters, including natural and synthetic steroids and hormones, pharmaceuticals, detergent metabolites, plasticizers, and fire retardants (Figure 6)(Kolpin et al. 2002). Many of these are biologically active and relevant at exceedingly low concentrations, and some share a common mode of action or affect related biochemical pathways.

Figure 6. Wastewater contamination in U.S. streams; frequency of detection and percent of total measured concentration for organic contaminants, by general use category (Kolpin et al. 2002).



The BE submitted by the EPA in support of consultation provides a useful summary of available literature to describe the presence of unconventional contaminants in wastewater, and current information regarding their potential for toxicological, neural, endocrine, reproductive, developmental, and behavioral effects in exposed aquatic life (EPA 2012a, pp. 97-113).

However, while current research continues to provide better information with which to understand the presence and potential effects of these contaminants, there are still a great many unanswered questions. As an indication of the scope of this problem, consider that that the U.S. public uses more than 200 varieties of prescribed medication (PEIAR in EPA 2012a, p. 97), and that many of these compounds and/or their metabolites are likely present at some concentration in both treated and untreated wastewaters.

Emerging contaminants, wastewater contaminants for which there is only incomplete information, include pharmaceuticals and personal care products (e.g., antibiotics, painkillers and anti-inflammatories, anti-depressants, fragrances, and compounds found in cosmetics), natural and synthetic steroids and hormones (e.g., cholesterol, estradiol, ethynyl estradiol, and 17a-estradiol), disinfectants and detergent metabolites (e.g., triclosan, phenol, nonylphenols, and octylphenols), plasticizers (e.g., bis-2-ethylhexyl phthalate-DEHP, diethyl phthalate-DEP), fire retardants (e.g., PBDEs, chlorinated phosphates), herbicides and pesticides (e.g., carbaryl, carbazole, diazinon, pentachlorophenol, and permethrin), and even common and seemingly innocuous compounds such as caffeine. For nearly all of these chemical compounds there is only incomplete information to describe their presence in treated and untreated wastewaters, the efficiency with which treatment processes accomplish removal from the waste stream, their fate and transport in the environment (including biotransformation and bioavailability), and their potential for independent, additive, antagonistic, and/or synergistic effects in exposed aquatic life.

There are at least three issues for the science of contaminant behavior in the environment that currently confound and will continue to confound our efforts to understand the potential effects of wastewater exposures (EPA 2012a, pp. 97, 98, 105): 1) wastewater discharges are an exceedingly complex and variable mixture of hundreds of chemical compounds; 2) ecologically relevant surface water concentrations are poorly understood and not always a focus for study or consideration; and, 3) there are a huge variety of potentially relevant acute and chronic "endpoints" (or biological responses). Mesocosm and caged fish studies have been employed to address some of these inherent challenges, but examining the full spectrum of relevant exposure scenarios will take many years of future research. Furthermore, to the extent that much toxicological research still focuses on lethal effects and/or developmental effects, and the variety of potentially relevant chronic and sub-lethal endpoints remains poorly defined, it will remain difficult to interpret the significance of exposures to unconventional wastewater pollutants.

Endocrine disruption, and the potential for resulting reproductive and developmental effects in aquatic life, is of particular concern. Some of the known or suspected EDCs present in wastewater include natural and synthetic steroids and hormones, phenols found in detergents, phthalates found in plasticizers, bisphenol A (BPA) found in plastics, and a number of anti-fungals and/or pesticides. EDCs interfere with or mimic the natural hormones responsible for maintenance, reproduction, development, and/or behavior in organisms (USGS 1998, p. 2). EDCs can act independently or as a complex mixture to reduce or suppress the production of natural hormones, affect the release of hormones from glands, simulate or counteract the action of hormones at target tissues, and/or speed-up the metabolism and thereby reduce the action of natural hormones. Wastewater discharges have been investigated as a common cause or partial cause for the occurrence of EDCs in surface waters, and have been implicated for observed endocrine disruption in some fish populations (Barber et al. 2012, pp. 1, 2).

City of Puyallup WWTP Discharges

Temperature

The Puyallup Tribe aquatic life criteria for temperature is 18 °C (7-DADMax), 7-Day Average of the Daily Maximum Temperature. Based on monthly discharge monitoring reports from the period 2003 thru 2011, the maximum temperature at point of discharge from the City of Puyallup WWTP was 23.6 °C (EPA 2012c, pp. 21, 22). Applying a two-dimensional model, ambient water quality data, and 99^{th} percentile effluent data, the EPA has determined that resulting water temperatures at the edge of the acute mixing zone are unlikely to exceed 19.4 °C (EPA 2012a, pp. 64, 65).

BOD_5 and Dissolved Oxygen

The Puyallup Tribe aquatic life criteria for dissolved oxygen is 8.0 mg/L. Based on monthly discharge monitoring reports from the period 2003 thru 2011, the maximum monthly average BOD_5 concentration at point of discharge from the City of Puyallup WWTP was 8.97 mg/L (EPA 2012c, pp. 21, 22). The EPA has estimated the dissolved oxygen deficit resulting from effluent discharge under critical conditions and has determined that the lowest foreseeable dissolved oxygen concentrations exceed 9.0 mg/L (EPA 2012a, p. 62).

Ammonia

The Puyallup Tribe toxics criteria for ammonia are: (Summer) 140 µg/L and 31 µg/L unionized ammonia, acute and chronic respectively; and, (Winter) 85 µg/L and 19 µg/L unionized ammonia, acute and chronic respectively. Effluent limitations established by the EPA for the proposed permit would allow daily maximum discharge concentrations of 120.0 µg/L and 241.5 µg/L unionized ammonia, during summer and winter respectively. Based on monthly discharge monitoring reports from the period 2003 thru 2011, the highest daily maximum total ammonia (Ammonia-N) concentration at point of discharge from the City of Puyallup WWTP was 9.25 mg/L (EPA 2012c, pp. 21, 22), which equates to an unionized ammonia concentration of approximately 139 µg/L (i.e., at 1.5 percent of the total ammonia concentration).

The EPA has modeled effluent plume dynamics for the City of Puyallup WWTP applying conservative assumptions (EPA 2012a, pp. 10-13). Using ambient water quality data and 99^{th} percentile WWTP effluent concentrations, the EPA has demonstrated that the effluent plume becomes completely mixed at a distance of approximately 1.2 miles downstream. At a distance of approximately 1.2 miles downstream, ammonia present in the effluent plume becomes fully-mixed such that there is no measurable difference from background (EPA 2012a, pp. 10-13).

Copper

The Puyallup Tribe acute and chronic toxics criteria for dissolved copper are 6.97 µg/L and 3.17 µg/L, respectively. Effluent limitations established by the EPA for the proposed permit would allow a daily maximum discharge concentration of 13.7 µg/L total copper, which equates to a dissolved copper concentration of approximately 11.8 µg/L (i.e., applying a total-to-dissolved conversion factor of 0.862).

Based on monthly discharge monitoring reports from the period 2003 thru 2011, the highest daily maximum total copper concentration at point of discharge from the City of Puyallup WWTP was 20.9 µg/L (EPA 2012c, pp. 21, 22), which equates to a dissolved copper concentration of approximately 18.0 µg/L. These data make clear that the City of Puyallup WWTP sometimes operates outside of the effluent limitations which the EPA currently proposes to include in Permit No.WA-003716-8 (i.e., total copper parameter).

Applying a two-dimensional model, ambient water quality data, and 99^{th} percentile effluent data, the EPA has determined that copper present in the effluent plume becomes fully-mixed within the allowable acute mixing zone, such that there is no measurable difference from background at the edge of the acute mixing zone (EPA 2012a, pp. 10-13, 75-78).

Zinc

The Puyallup Tribe acute and chronic toxics criteria for dissolved zinc are 51.5 µg/L and 29.7 µg/L, respectively. Based on monthly discharge monitoring reports from the period 2003 thru 2011, the highest daily maximum total zinc concentration at point of discharge from the City of Puyallup WWTP was 72.0 µg/L (EPA 2012c, pp. 21, 22), which equates to a dissolved zinc concentration of approximately 64.2 µg/L (i.e., applying a total-to-dissolved conversion factor of 0.891). Applying a two-dimensional model, ambient water quality data, and 99^{th} percentile effluent data, the EPA has determined that zinc present in the effluent plume becomes fully-mixed within the allowable chronic mixing zone, such that there is no measurable difference from background at the edge of the chronic mixing zone (EPA 2012a, pp. 10-13, 95-97).

pH

The Puyallup Tribe aquatic life criteria for pH is 6.5 to 8.5, with human-caused variation of less than 0.5 units. Effluent limitations established by the EPA for the proposed permit would allow discharges across a pH range of 6.5 to 9.0. Based on monthly discharge monitoring reports from the period 2003 thru 2011, the City of Puyallup WWTP produced discharges across a pH range of 6.3 to 7.6 (EPA 2012c, pp. 21, 22). These data make clear that the City of Puyallup WWTP sometimes operates outside of the effluent limitations which the EPA currently proposes to include in Permit No.WA-003716-8 (i.e., pH parameter). However, monitoring data also suggest that pH excursions return to the normal range within the allowable chronic mixing zone (EPA 2012a, pp. 60, 61).

Total Suspended Solids and Sediment-Bound Contamination

Effluent limitations established by the EPA for the proposed permit would allow average weekly and monthly TSS discharge concentrations of 45 mg/L and 30 mg/L, respectively. Based on monthly discharge monitoring reports from the period 2003 thru 2011, the maximum monthly average TSS concentration at point of discharge from the City of Puyallup WWTP was 12.4

mg/L (EPA 2012c, pp. 21, 22), well below the allowable effluent limitation. The City of Puyallup WWTP provides an extended solids retention time, and produces treated effluent which contains low to very low TSS concentrations. The treatment processes typically produce effluent ranging between 2 and 4 mg/L TSS (EPA 2012a, pp. 44, 49, 56).

The EPA has summarized results from a study investigating the removal of conventional pollutants, pharmaceuticals, hormones, natural and synthetic endocrine disruptors, and other organic compounds at five municipal WWTPs from around the Puget Sound region (Lubliner et al. 2010), including the City of Puyallup WWTP (EPA 2012a, pp. 44-51). The City of Puyallup WWTP was found to remove approximately 99 percent of the influent TSS and many of the EDCs typically found in secondary treated effluent. Treatment processes employed at the City of Puyallup WWTP successfully breakdown and remove numerous compounds that would otherwise be discharged with the treated effluent (EPA 2012a, pp. 44, 49). Many of the hormones and phthalates are removed to undetectable levels. The natural and synthetic reproductive hormones estradiol, ethynyl estradiol, and 17a-estradiol are all removed at 85 to 95 percent of their influent concentrations, resulting in undetectable levels of less than 2 parts per trillion (EPA 2012a, p. 48).

Adverse Effects of the Action

The proposed action will contribute to existing degraded water quality and instream habitat conditions and is likely to measurably and adversely affect bull trout individuals. The proposed action may also have measurable and adverse long-term effects to bull trout prey resources.

Discharges from the City of Puyallup WWTP cause or contribute to sources of stress that act cumulatively to significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and/or shelter). Bull trout are exposed to discharges from the City of Puyallup WWTP within the allowable acute and chronic mixing zones. Sub-lethal exposures may discourage or impair free movement through a portion of the action area, may impair olfaction and/or locomotor performance, and impose a metabolic cost with potential consequences for the growth of individuals, their long-term survival, and/or reproduction.

The sub-sections below discuss effects to instream habitat conditions, adverse sub-lethal exposures and effects to individuals, and effects to bull trout prey resources.

Effects to Water Quality and Instream Habitat

Our analyses must integrate the baseline environmental conditions and context in order to accurately interpret the significance of sub-lethal exposures and effects. Here that context includes existing degraded habitat conditions along the lower Puyallup River and sources of stress that act cumulatively to disrupt normal bull trout behaviors (feeding, moving, and sheltering).

Our analyses must consider whether the action would result in permanent or long-term impacts to habitat, affect an already degraded environmental baseline, or further impair essential habitat functions. In this case, all three of these considerations have relevance. The lower Puyallup

River functions poorly as an essential migratory corridor and the City of Puyallup's continuous WWTP discharges add incrementally to the variety of stressors that disrupt normal bull trout behaviors. Baseline environmental conditions are moderately to severely impaired, and bull trout using the lower Puyallup River are challenged by the lack of instream habitat complexity and cover, side- and off-channel habitat, thermal refugia, and transitional estuarine habitat between the freshwater and marine environments.

Table 4 provides a summary comparison of ambient/background surface water quality conditions for select pollutant parameters, the proposed permit limits (or effluent limitations), expected maximum discharge concentrations, and related lowest observed effect levels (LOELs) or "thresholds for effect." Table 4 also reports the Puyallup Tribe aquatic life and toxics criteria for these same pollutant parameters, and the approximate distances downstream where the effluent plume becomes fully-mixed and pollutant concentrations become indiscernible from background water quality conditions.

Table 4. Ambient and effluent discharge concentrations, effect levels, and criteria for select pollutant parameters.

Pollutant / Parameter	**Ambient** / Background	Permit Limit	**Max At Discharge**	**LOEL** or Threshold	Acute WQS	Chronic WQS	**Full Mix**
Ammonia - N Total (mg/L)	0.04 – 0.53	16.1	9.25 mg/L	---	---	---	1.2 mi
Ammonia Unionized (µg/L)	0.6 – 7.95	242	139 µg/L	40 µg/L	140 S --- 85 W	31 S --- 19 W	1.2 mi
Dissolved Zinc (µg/L)	2.0 – 6.2	---	64.2 µg/L	+ 5.6 µg/L	51.5	29.7	~ 300 ft
Dissolved Copper (µg/L)	2.0 – 7.5	11.8	18.0 µg/L	+ 2 µg/L	6.97	3.17	< 30 ft
Temperature (°C)	15 – 20	---	23.6 °C	16 °C	18 °C	18 °C	~ 300 ft

Observed ambient water temperatures and background levels of ammonia and dissolved metals (zinc and copper) create stress for salmonids migrating through the lower Puyallup River, including adult and subadult bull trout. Discharges from the City of Puyallup WWTP are a continuous source of ammonia and dissolved metals, and create a measurable plume within which bull trout are exposed to elevated temperatures, unionized ammonia, dissolved zinc, and dissolved copper concentrations.

An earlier section discussed City of Puyallup WWTP discharges in detail, including the influence and end result of effluent plume dynamics and dilution within the allowable mixing zones. For most conventional pollutants and parameters, mixing and dilution limit the area where concentrations exceeding LOELs can be expected. Within the allowable mixing zones, LOELs are exceeded for temperature, unionized ammonia, dissolved zinc, and dissolved copper.

Temperatures decline to the ambient/background condition before reaching the edge of the chronic mixing zone. However, within the action area ambient temperatures routinely exceed 16 °C on a seasonal basis. Elevated ambient surface water temperatures are a source of stress for bull trout that migrate along the lower Puyallup River. Discharges from the City of Puyallup WWTP contribute to this source of stress.

A similar scenario would appear to hold for both dissolved zinc and dissolved copper. Dissolved zinc and copper concentrations decline to the ambient/background condition before reaching the edge of the chronic mixing zone. Within the mixing zones, discharges from the City of Puyallup WWTP create a measurable plume within which bull trout are exposed to dissolved zinc and copper concentrations. It warrants noting here, that according to best available science, the Puyallup Tribe toxics criteria for dissolved zinc and copper are not wholly protective of aquatic life. The chronic WQS for dissolved zinc and copper are 29.7 µg/L and 3.17 µg/L, respectively. These exceed the LOELs for zinc (+ 5.6 µg/L) and copper (+ 2 µg/L) that the Washington Fish and Wildlife Office uses to assess potential effects resulting from exposures to these dissolved metals.

Within the allowable mixing zones, unionized ammonia concentrations routinely exceed the LOEL (40 µg/L). In addition, while for all other conventional pollutants and parameters it appears that concentrations decline to the ambient/background condition before reaching the edge of the chronic mixing zone, this is not the case for ammonia. According to model outputs, ammonia present in the effluent plume does not become fully-mixed (i.e., no measurable difference from background) until the plume is carried approximately 1.2 miles downstream (EPA 2012a, pp. 10-13).

Even though the City of Puyallup WWTP produces treated effluent which contains low to very low TSS concentrations, TSS loads likely still fall within the range of 50,000 to 100,000 pounds per year. These solids are a source of sediment-bound contamination which may affect sediment quality, and therefore instream habitat conditions, downstream of the point of discharge. However, there are few if any data to indicate a trend in sediment quality that is attributable to discharges from the City of Puyallup WWTP alone. Discharges from the City of Puyallup WWTP may contribute to degraded sediment quality conditions along the lower Puyallup River, but there is no reliable information with which to assess the magnitude of this potential effect.

The proposed action will contribute to, and may further degrade, existing impaired water quality conditions within the action area. These degraded water quality conditions create stress for salmonids migrating through the lower Puyallup River. Because the Puyallup River core area's anadromous bull trout are exposed repeatedly to these degraded conditions when making annual migrations through the action area, it becomes more likely that these effects to habitat conditions and associated sub-lethal exposures and effects will act cumulatively to reduce the growth of some individuals, their long-term survival, and/or reproduction.

Adverse Sub-Lethal Exposures and Effects to Individuals

Discharges from the City of Puyallup WWTP are a continuous source of ammonia and dissolved metals, and create a measurable plume within which bull trout are exposed to elevated temperatures, unionized ammonia, dissolved zinc, and dissolved copper concentrations. Within the allowable mixing zones, LOELs are exceeded for temperature, unionized ammonia, dissolved zinc, and dissolved copper.

Temperatures and dissolved zinc and copper concentrations decline to the ambient/background condition before reaching the edge of the chronic mixing zone. However, on a seasonal basis ambient water temperatures are a source of stress for salmonids migrating through the lower Puyallup River, and background levels of dissolved zinc and copper frequently approach or exceed concentrations known to have measurable, sub-lethal effects to fish. Within the allowable mixing zones, unionized ammonia concentrations routinely exceed the LOEL (40 µg/L). Ammonia present in the effluent plume may also, under some conditions, exceed background concentrations far beyond the edge of the chronic mixing zone.

Bull trout that are exposed to discharges from the City of Puyallup WWTP experience these discharges as a complex and variable mixture. Also, given the background water quality conditions that prevail, we must assume that some bull trout individuals are already suffering stress and/or other measurable sub-lethal effects prior to entering the action area, and before they are exposed to discharges from the City of Puyallup WWTP. Future discharges from the WWTP are reasonably certain to contribute to these sources of stress.

Effects to aquatic life are influenced by the size and dilution capacity of the receiving waterbody, background water quality conditions, concurrent discharges and/or background levels of other contaminants, frequency and duration of exposure, concentration and relative toxicity of the pollutant(s), biological uptake and availability, and life stage. Sources of uncertainty include the effect of intermittent, episodic, or transient exposures (Burton et al. 2000, p. ab; Marsalek et al. 1999, p. 34); variations in tolerance among exposed individuals and/or populations (Ellis 2000, p. 89; Hodson 1988, p. ab; Lloyd 1987, p. 502); and, the potential for synergistic or additive effects among pollutants with similar or the same modes of toxic action (Burton et al. 2000, p. ab; Ellis 2000, p. 88; Lloyd 1987, p. 494). Burton et al. (2000, p. ab) warn that traditional toxicity tests may not lead to reliable predictions or conclusions if not tailored to reflect real-world patterns of exposure. Lloyd (1987, pp. 492, 501) has expressed concern that pollutants may have increased toxicity to salmonids under conditions of reduced dissolved oxygen, and has advised that aquatic life criteria should apply to whole groups of contaminants with common modes of action, rather than individual contaminants.

The best available science leads us to conclude that discharges from the City of Puyallup WWTP will cause measurable adverse effects in some bull trout, and also act cumulatively to significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and/or shelter).

Measurable adverse effects to individuals may at times include an avoidance response which prevents or discourages free movement through the action area. Within the mixing zone, dissolved zinc concentrations routinely exceed the LOEL associated with an avoidance response (+ 5.6 µg/L dissolved zinc). Given the size, dimensions, and position of the allowable mixing zone, it is unlikely that discharges from the City of Puyallup WWTP would present a complete barrier to bull trout migration. However, these discharges are reasonably certain to prevent bull trout from utilizing preferred habitat (e.g., deeper, cooler portions of the channel).

Measurable adverse effects to individuals are reasonably certain to include impaired olfactory responsiveness. Within the mixing zone, dissolved copper concentrations routinely exceed the LOEL associated with sensory physiological impairment (+ 2 μg/L dissolved copper). When salmonids are exposed and experience temporary impaired responsiveness, they become inherently less capable of detecting and acting upon important olfactory cues. These exposures and resulting temporary impairment may inhibit the ability to detect and avoid predators, and the ability to locate and capture prey. Impaired olfactory responsiveness may also inhibit the ability to detect and avoid degraded water quality conditions encountered elsewhere (e.g., other point discharges). Migrating salmonids rely upon olfactory cues as a means of locating their natal waters, and in this respect dissolved copper exposures resulting in sensory physiological impairment fundamentally challenge the ability of individuals to successfully locate and reach their natal waters. These effects to individuals, resulting from exposure to dissolved copper concentrations within the allowable mixing zones, create a likelihood of injury by significantly disrupting normal bull trout behaviors.

Measurable adverse effects to individuals are reasonably certain to include reduced locomotor performance. Within the mixing zone, unionized ammonia concentrations routinely exceed the LOEL associated with reduced swimming performance (40 μg/L). Bull trout foraging and migrating through the action area are exposed to elevated ammonia concentrations. These temporary exposures may prevent some individuals from achieving and maintaining normal swimming speeds. It is reasonable to assume that bull trout experiencing reduced locomotor performance will be less capable of negotiating velocity barriers (e.g., seasonal high flows), and/or less capable of achieving the bursts of speed necessary to successfully evade predators and capture prey. These effects to individuals, resulting from exposure to unionized ammonia within the allowable mixing zones, create a likelihood of injury by significantly disrupting normal bull trout behaviors.

The environmental stressors that are present in the effluent plume, including elevated temperatures, unionized ammonia, dissolved zinc and copper concentrations, do not act alone or in isolation. Instead, exposed bull trout are likely to experience a degree of physiological impairment and metabolic stress that reflects the additive effects of these sub-lethal exposures.

For bull trout individuals that are exposed to the effluent plume, probably the most certain and significant measurable adverse effect will be an increase in general, whole-body, metabolic stress, and a corresponding reduction of aerobic scope. Contaminant exposures impose a metabolic cost and may compromise growth, survival, or reproduction (Barton 2002; Beyers et al. 1999; Coghlan Jr and Ringler 2005; McGeer et al. 2000; Scott and Sloman 2004). Metabolic costs rise exponentially with temperature. Within the action area bull trout are exposed to temperatures that may inhibit food consumption and efficient conversion (Selong et al. 2001, p. 1033). These exposures deplete energy reserves and, at least temporarily, reduce the aerobic scope available to complete essential bodily functions. Exposures within the effluent plume impose a metabolic cost with potential consequences for the growth of individuals, the success of their annual migrations, long-term survival, and/or reproductive potential (or fecundity).

The Puyallup River core area's anadromous bull trout are exposed repeatedly to these degraded conditions when making annual migrations through the action area. For these individuals, it becomes more likely that sub-lethal exposures and effects will act cumulatively to reduce long-term growth, survival, and/or reproduction.

Effects to Bull Trout Prey Resources

The action area is an essential migratory corridor for the Puyallup River's native salmon and steelhead trout populations. These native fish populations represent important prey resources for bull trout of the Puget Sound Management Unit.

The same adverse effects described above, for bull trout individuals and habitat, also have significance for the size and health of the bull trout prey base. Degraded baseline conditions limit productivity of the Puyallup River's native salmon and steelhead trout populations and discharges from the City of Puyallup WWTP add incrementally to this degraded baseline.

We assume that some native salmon and steelhead trout using the action area will suffer the same adverse effects described for bull trout, including increased metabolic stress, reduced locomotor performance, and impaired olfactory responsiveness. These adverse exposures and effects may compromise the growth, long-term survival, and reproductive potential (or fecundity) of some individuals.

A 2002 review of Puyallup basin salmon and steelhead stock status found that four of twelve populations are "healthy" (including Puyallup and White River coho), three of twelve populations are of "unknown" status (including Puyallup and White River fall Chinook), four of twelve populations are "depressed" (including Puyallup, Carbon, and White River winter steelhead), and one population is "critical" (White River spring Chinook)(WDFW 2002).

Notwithstanding inherent variability from year to year, information taken from the *2010-2011 Annual Salmon, Steelhead, and Bull Trout Report for the Puyallup/White River Watershed* would seem to indicate the following (Marks et al. 2011):

- Based on counts at the Buckley Diversion and redd surveys, Chinook salmon numbers appear stable since 2002, except for the possibility of unusually high returns during 2006 and 2007 (p. 159).

- Based on counts at the Buckley Diversion, coho salmon numbers appear stable or modestly decreasing since 2002 (p. 160).

- Based on counts at the Buckley Diversion and redd surveys, steelhead salmon numbers appear stable or modestly increasing since 2002, with recent 10-year peak returns during 2010 and 2011 (p. 161).

- Based on counts at the Buckley Diversion, coho salmon numbers appear stable or modestly increasing since 2002 (p. 162).

Despite heavily degraded flooplain, riparian, and instream habitat conditions along the lower Puyallup River, the watershed still supports large and robust native salmon and steelhead populations. There is little or no information to suggest that prey resources are limiting for bull trout of the Puyallup River core area.

We expect that the proposed action will contribute to existing degraded water quality and instream habitat conditions, will cause or contribute to sources of stress that act cumulatively to significantly disrupt normal native fish behaviors, and may have potential consequences for the growth of individuals, their long-term survival, and/or reproduction. However, we are not able, with available information, to determine the magnitude of potential effects to the bull trout prey base. While it is possible that discharges from the City of Puyallup WWTP may measurably affect the abundance and availability of prey within the action area, available information indicates that prey availability is not a limiting factor for bull trout utilizing the lower Puyallup River, and we expect that bull trout foraging and migrating in the action area will continue to find sufficient prey resources.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action (USFWS and NMFS 1998).

The proposed action will not create or provide additional WWTP capacity. The proposed action will have no foreseeable indirect effects to the pattern or rate of land use conversion or development.

Continued operation of the City of Puyallup WWTP will result in measurable adverse effects to bull trout, their habitat, and prey resources. Discharge of treated and disinfected wastewater from the City of Puyallup WWTP causes and contributes to degraded surface water quality conditions within the action area. These degraded surface water quality conditions are a source of metabolic stress for exposed bull trout, and may at times measurably and significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and shelter).

The action's potential adverse effects to bull trout result from operational discharge of treated and disinfected wastewater. Discharges will continue out into the future, and therefore these potential adverse effects also represent indirect effects occurring later in time. Previous sub-sections have addressed all of the foreseeable effects to bull trout, both direct and indirect.

Effects of Interrelated & Interdependent Actions

Interrelated actions are defined as actions "that are part of a larger action and depend on the larger action for their justification"; interdependent actions are defined as actions "that have no independent utility apart from the action under consideration" (50 CFR section 402.02).

Biosolids management and disposal are regulated under a separate permit (EPA 2012c, p. 10).

Therefore the sites and/or facilities where biosolids are processed and disposed are not included as part of the action area, and these activities are not addressed by the Opinion.

We conclude that there are no interrelated or interdependent actions with potential effects to the bull trout, their habitat, or prey resources. The Service expects no foreseeable adverse effects attributable to interrelated or interdependent actions.

Synthesis – Effects to Numbers, Reproduction, and Distribution

Habitats along the lower Puyallup River support all of the core area's natal anadromous bull trout, and perhaps some fluvial individuals. The lower Puyallup River provides FMO habitats which are essential to these anadromous bull trout. The Puyallup River core area's anadromous bull trout forage and migrate along the lower Puyallup River when making seasonal movements to and from the marine waters.

The Service expects that low numbers of adult and subadult bull trout may occupy the action area at any time of year, although the numbers present most likely peak between the months of April and August. Information is not available to reliably estimate the number of bull trout that forage, migrate, and overwinter in the action area.

Bull trout that migrate from the lower Puyallup River to the upper watershed's spawning and rearing habitats face a number of challenges, including: 1) high temperatures and low dissolved oxygen conditions in the nearshore marine environment; 2) lack of functioning transitional habitat for fish acclimating to or from the marine environment; 3) little or no off-channel habitat or instream habitat complexity offering refugia from high-flows; 4) other point discharges and the effluent plumes they create; 5) high temperatures and low dissolved oxygen conditions in upstream reaches (e.g., the lower White River); and, 6) impassable man-made barriers between the lower river and headwater spawning and rearing habitats.

Continued operation of the City of Puyallup WWTP will result in measurable adverse effects to bull trout and their habitat. Discharge of treated and disinfected wastewater from the City of Puyallup WWTP causes and contributes to degraded water quality conditions within the action area. These degraded water quality conditions are a source of metabolic stress for exposed bull trout and are reasonably certain to significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and shelter).

Bull trout that are exposed to discharges from the City of Puyallup WWTP experience these discharges as a complex and variable mixture. Also, given the background water quality conditions that prevail, we must assume that some bull trout individuals are already suffering stress and/or other measurable sub-lethal effects prior to entering the action area, and before they are exposed to discharges from the City of Puyallup WWTP. Discharges from the City of Puyallup WWTP represent only one challenge, and one source of stress, along a lower river that presents many such challenges. Future discharges from the WWTP are reasonably certain to contribute to these sources of stress.

The best available science leads us to conclude that discharges from the City of Puyallup WWTP will cause measurable adverse effects in some bull trout, and also act cumulatively to significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and/or shelter). Discharges and resulting exposures within the allowable mixing zones will prevent bull trout from utilizing preferred habitat, impair olfactory responsiveness and locomotor performance, and cause an increase in general, whole-body, metabolic stress, and a corresponding reduction of aerobic scope. These effects to individuals create a likelihood of injury by significantly disrupting normal bull trout behaviors.

We expect that most bull trout exposed to discharges from the City of Puyallup WWTP will suffer only modest sub-lethal effects. The most certain and significant measurable adverse effect will be an increase in general, whole-body, metabolic stress. Exposure to discharges from the City of Puyallup WWTP will deplete energy reserves and reduce the aerobic scope available to complete essential bodily functions. The Puyallup River core area's anadromous bull trout are exposed repeatedly to these degraded conditions when making annual migrations through the action area. For these individuals, it becomes more likely that sub-lethal exposures and effects will act cumulatively to reduce long-term growth, survival, and/or reproduction.

It is possible that these exposures and other environmental stressors may act cumulatively to weaken or retard the growth of individuals, increase their susceptibility to disease, and reduce their long-term survival and/or reproductive potential (or fecundity). The cumulative effects of these exposures and other environmental stressors may also render some individuals incapable of making the long migration to the upper watershed, or otherwise reduce the success of annual migrations.

We are not able, with available information, to quantify the action's incremental effects to the long-term growth, survival, and/or reproductive potential of individual bull trout. However, we can say that discharges from the City of Puyallup WWTP will not prevent bull trout from foraging and migrating in the action area. Furthermore, we expect that bull trout will continue to find sufficient prey resources in the action area.

Because discharges from the City of Puyallup WWTP will create a likelihood of injury by significantly disrupting normal bull trout behaviors, we must acknowledge some potential for long-term effects to bull trout numbers (abundance) or reproduction (productivity). However, affected individuals likely originate from all five of the Puyallup River core area's local populations, and we expect that any attributable long-term effects to numbers or reproduction will not be measurable or discernible at the scale of the local populations or core area.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Recent years have seen several habitat restoration activities planned and implemented along the lower Puyallup River, including activities sponsored by the Puyallup Tribe. These activities have created and restored estuarine and intertidal habitats, have set back levees and/or provided fish passage through levees, and have reconnected, created, and/or restored off-channel habitats, wetlands, and refugia. These activities have restored a small fraction of the habitat which was previously lost or unavailable, but their importance cannot be overstated. Given the severely degraded habitat conditions that persist throughout most of the lower river, even small and gradual improvements should help to support stronger and more resilient native fish populations.

The lower Puyallup River floodplain is today very heavily developed. It is unlikely that future development within the action area will further degrade floodplain, riparian, or instream habitat conditions. Instead, we expect that redevelopment according to current environmental standards may over time make modest improvements to these conditions.

Climate change and its potential effects should also be considered when describing possible future actions and conditions within the action area. In particular, potential effects to seasonal patterns of precipitation, surface water temperatures, and stream hydrology could present dramatically altered conditions for bull trout and other cold-water fish of the Pacific Northwest. A recent, wide-ranging assessment of these potential effects has identified the following trends (Littel et al. 2009):

- Wetter autumns and winters, drier summers, and reductions in permanent snowpack.
- Higher winter stream flows, earlier spring snowmelt and peak spring stream flow, and lower summer stream flows in rivers that depend on snowmelt.
- Rising stream temperatures and a corresponding reduction in the quality and extent of cold-water habitats.

Littell et al. (2009) have concluded that the combined effects of warming stream temperatures and altered stream flows will very likely reduce the reproductive success of many salmon populations. As much as one-third of the current habitat in the Pacific Northwest may no longer be suitable by the end of the century. Rising stream temperatures and temporal shifts in stream hydrology will have more pronounced effects on the systems, populations, and life-history types that are most sensitive.

Taken as a whole, the foreseeable future State, tribal, local, and private actions may have both beneficial effects and adverse effects to bull trout. Some of these actions are likely to improve conditions in the action area for bull trout. However, we also expect that other actions, and the effects of climate change, may further degrade conditions for bull trout and the function of FMO habitat along the lower Puyallup River.

CONCLUSION

We have reviewed the current status of the bull trout in its coterminous range, the environmental baseline for the action area, the direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area.

It is our Biological Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout in its coterminous range. This determination is based on the following:

- The action area provides core FMO habitat for bull trout. FMO habitat is important to bull trout of the Puget Sound Management Unit for maintaining diversity of life history forms and for providing access to productive foraging areas. Habitats along the lower Puyallup River support natal anadromous bull trout, and perhaps some fluvial individuals, originating from the core area's five (or more) local populations. The Service expects that low numbers of adult and subadult bull trout may occupy the action area at any time of year, although the numbers present most likely peak between the months of April and August.

- Continued operation of the City of Puyallup WWTP will result in measurable adverse effects to bull trout, their habitat, and prey resources. Discharge of treated and disinfected wastewater from the City of Puyallup WWTP causes and contributes to degraded water quality conditions within the action area. These degraded water quality conditions are a source of metabolic stress for exposed bull trout and are reasonably certain to significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and shelter).

- The proposed action will contribute to, and may further degrade, existing, impaired water quality conditions within the action area. These degraded water quality conditions create stress for salmonids migrating through the lower Puyallup River. Because the Puyallup River core area's anadromous bull trout are exposed repeatedly to these degraded conditions when making annual migrations through the action area, it becomes more likely that these effects to habitat conditions and associated sub-lethal exposures and effects will act cumulatively to reduce the growth of some individuals, their long-term survival, and/or reproduction.

- The best available science leads us to conclude that sub-lethal exposures to elevated temperature, unionized ammonia, and dissolved metals will cause measurable adverse effects in some bull trout, and to bull trout prey resources within the action area. Measurable adverse effects may include an avoidance response which prevents or discourages free movement through the action area, impaired olfactory responsiveness, reduced locomotor performance, and increased whole-body metabolic stress. These effects to individuals create a likelihood of injury by significantly disrupting normal bull trout behaviors.

- The action area is an essential migratory corridor for the Puyallup River's native salmon and steelhead trout populations. These native fish populations represent important prey resources for bull trout of the Puget Sound Management Unit. We expect that some native fish using the action area will suffer the same adverse effects described for bull trout. However, available information indicates that prey availability is not a limiting factor for bull trout utilizing the lower Puyallup River, and we expect that bull trout foraging and migrating in the action area will continue to find sufficient prey resources.

- Discharges from the City of Puyallup WWTP represent one challenge or source of stress, among many, along the lower Puyallup River. Future discharges from the WWTP will contribute to these sources of stress. Exposure to discharges from the City of Puyallup WWTP and other environmental stressors may act cumulatively to weaken or retard the growth of individuals, increase their susceptibility to disease, reduce their long-term survival, and/or reproductive potential (or fecundity). The cumulative effects of these exposures may also render some individuals incapable of making the long migration to the upper watershed, or otherwise reduce the success of annual migrations.

- We are not able, with available information, to quantify the action's incremental effects to the long-term growth, survival, and/or reproductive potential of individual bull trout. However, discharges from the City of Puyallup WWTP will not prevent bull trout from foraging and migrating in the action area, and we expect that bull trout will continue to find sufficient prey resources in the action area.

- Because discharges from the City of Puyallup WWTP will create a likelihood of injury by significantly disrupting normal bull trout behaviors, we must acknowledge some potential for long-term effects to bull trout numbers (abundance) or reproduction (productivity). However, affected individuals likely originate from all five of the Puyallup River core area's local populations, and we expect that any attributable long-term effects to numbers or reproduction will not be measurable or discernible at the scale of the local populations.

- The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will result in adverse effects to bull trout, but will not appreciably reduce the likelihood of survival and recovery of the species. The anticipated direct and indirect effects of the action will not reduce bull trout numbers, reproduction, or distribution sufficient to appreciably reduce the likelihood of survival and recovery at the scale of the local populations, core area, or Puget Sound interim recovery unit.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is defined by the Service as an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the EPA so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The EPA has a continuing duty to regulate the activity covered by this incidental take statement. If the EPA (1) fails to assume and implement the terms and conditions or (2) fails to require the contractor or applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the EPA must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR section 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

We anticipate that take in the form of harassment of adult and subadult bull trout from the Puyallup River core area will result from the proposed action.

The Service expects that incidental take of bull trout will be difficult to detect or quantify for the following reasons: 1) the low likelihood of finding dead or injured adults or subadults; 2) delayed mortality; and, 3) losses may be masked by seasonal fluctuations in numbers. Where this is the case, we use a description of the affected habitat (i.e., physical extent, frequency, and duration), and the intensity of temporary exposures, as a surrogate indicator of take.

We anticipate the following forms and amount of take:

1. Incidental take of bull trout in the form of harassment resulting from discharge of treated and disinfected wastewater and resulting degraded surface water quality conditions within the action area. Discharges from the City of Puyallup WWTP are a continuous source of ammonia and dissolved metals, and create a measurable plume within which

bull trout are exposed to elevated temperatures, unionized ammonia, dissolved zinc, and dissolved copper concentrations. These degraded water quality conditions are a source of metabolic stress for exposed bull trout and are reasonably certain to significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and shelter).

- All adult and subadult bull trout foraging or migrating within the allowable WWTP mixing zone, extending waterward of the Puyallup River's left-bank (RM 6.9) a distance of approximately 50 ft, 300 ft downstream, and 100 ft upstream. Bull trout exposed to elevated temperatures (greater than16 °C), unionized ammonia (greater than 40 µg/L), dissolved zinc (+5.6 µg/L), and dissolved copper concentrations (+2 µg/L) within the allowable WWTP mixing zone will be harassed for the duration of the issued permit (2012-2017).

EFFECT OF THE TAKE

In the accompanying Opinion, we determined that the level of anticipated take is not likely to result in jeopardy to the bull trout.

REASONABLE AND PRUDENT MEASURES

The following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the impact of incidental take to bull trout:

1. Monitor incidental take caused by discharges from the City of Puyallup WWTP and resulting degraded surface water quality conditions within the action area.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the EPA must comply with the following terms and conditions, which implement the RPMs described above. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPM 1:

1. The EPA shall provide an annual report to the Service by February 15 each year of the permit term (2012-2017). The annual report shall compile and summarize data and information from Discharge Monitoring Reports submitted by the City of Puyallup, and shall include the following:

    a. A summary of maximum reported effluent discharge concentrations.

    b. A summary of any reported effluent limit violations.

c. A summary of any reported emergency and/or non-compliance events, including any instances when the WWTP discharged under bypass or upset conditions.

d. A summary of surface/receiving water monitoring data.

e. Results of annual Whole Effluent Toxicity testing.

f. A summary of any significant revisions to the facility operation and maintenance (O&M) plan.

2. The EPA shall submit annual reports to the Washington Fish and Wildlife Office in Lacey, Washington (Attn: Federal Activities Branch, Division of Consultation and Technical Assistance).

We expect that the amount or extent of incidental take described above will not be exceeded as a result of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The EPA must provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

The Service is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Service's Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recommends the following to the EPA:

1. The Puyallup Tribe's current Water Quality Standards (WQS) became effective on October 31, 1994. Revised WQS were proposed during 2005. Based on our reading of the proposed WQS (Ridolfi Inc. 2005, Revised 3 May 2011), these revised criteria would be modestly more stringent for at least three pollutant parameters: ammonia (summer; acute), copper (acute and chronic), and zinc (acute). The current Puyallup Tribe toxics criteria for dissolved zinc and copper are not wholly protective of aquatic life. Therefore, we recommend that the EPA and Puyallup Tribe complete the public involvement process begun during 2005. The EPA should consider and approve revised Puyallup Tribe WQS which are more stringent and wholly protective of aquatic life.

2. The EPA and City of Puyallup should evaluate current operating conditions and consider available alternatives for lowering the temperature of WWTP discharges.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR section 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

APPENDICES

Appendix A: Status of the Species (Bull Trout; Coterminous Range)

APPENDIX A: Status of the Species (Bull Trout; Coterminous Range)

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